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Artificial Insemination

THE artificial insemination of cattle has, during the last 10 years, developed enormously, and at the present time more than 50 per cent. of the cattle in this country are being bred by this means. It is natural that alongside these developments interest should turn to other species, and of these the pig is obviously the most important. Quite apart from the difficulty which many small pig-keepers find in getting their sows served, the opportunities for livestock improvement in the pig are greater than in any other of the domestic species.

Early progeny results in cattle were disappointing and these experiences indicated that the selection of a sire on ancestory records was a pure gamble however much care was devoted to it. Extremely rapid development made it impossible to obtain sufficient proven sires, and consequently the over-all improvement achieved in the early years was negligible. In order to make sure that the same thing does not happen in the case of the pig, it is essential to ensure that facilities are available for either progeny testing or for obtaining progeny tested sires; for even with present techniques a boar might sire up to 20,000 offspring in a single year. Either the organisations running pig A.I. will have to obtain facilities for testing in the National Testing Stations, five of which are shortly to be established, or they will have to set up their own stations and compare the progeny of groups of boars under standard conditions selecting the best boar from each group for extensive service.

The development of artificial insemination in pigs was brought to a head by the work of Glover at Cambridge who drew attention to its possibilities, and together with Mann carried out biochemical studies on the composition of boar semen.

Shortly afterwards, Roy and Bishop working in the same laboratory showed that the amino acid glycine, would prolong the life of boar sperm stored in the refrigerator at 5° C.

The work so far had been confined to the laboratory bench and it was not until Polge joined the Cambridge Unit that the practical application of the technique was investigated in this country.*

The veterinary staffs of several of the private centres operating in England became interested in the possibilities of the technique and an experimental service was begun at Dartington Hall and Lyndhurst, in addition to Cambridge. Several other centres are expecting to begin a service within the next few months. Because of the difficulty of providing sufficient animals at research units, much of the applied research into pig A.I. must of necessity come through the field stations; and the veterinary staff of these stations, by collaborating in experiments, should be able to provide the answer to many of the existing problems in a much shorter time than would be possible in any single laboratory. The problems to be solved are formidable. Questions such as optimum dosage, maximum dilution, comparison of dilutors, influence of antibiotics and so forth have yet to be tested on a field scale. These factors will inevitably be a problem of a Centre veterinary staff, leaving the more fundamental work of storage and deep freezing, etc., to the laboratory worker. Fundamental physiology of the reproductive process in the sow is not at all well known, and alongside the field work and research into storage of semen, it will be necessary to carry out investigations into this aspect of pig fertility.

This need not delay the development of the technique, for there are many techniques in use in biological science which work perfectly satisfactorily, but in which the reason for success is not known.

Experiments by centres so far has indicated that the percentage of pregnancy to a single service is below that which is obtained by natural mating, although the litter size of animals becoming pregnant has been satisfactory.

It is only by patient investigation of variations of the techniques that the factors which might be

* A paper by C. Polge follows this leading article.

(*Concluded at foot of col. 1 overleaf*)

Artificial Insemination in Pigs

BY

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Introduction

TWENTY years ago, artificial insemination in farm animals had reached the threshold of a new era in the course of its development. At that time, the possibilities of this technique of breeding were just beginning to be realised and foundations were being laid for its application in several species. By the early 1930's, for instance, successful experiments in artificial insemination had already been carried out on horses, cattle, sheep and pigs (Milovanov, 1934) and it would have appeared that, although detailed knowledge was still lacking, the stage was set for advances in all the most important types of farm animal.

Since this early work, however, there has occurred a sensational expansion in the field of artificial insemination in cattle, which has overshadowed to a large extent any advances in the other animals. The emphasis on cattle, which was initiated by the discovery of improved diluting fluids for bull semen (Lardy & Phillips, 1939) and spurred on by a rapidly growing demand from farmers, increased tremendously and concentrated the bulk of experimental work on artificial insemination around this one species. As far as artificial insemination in the pig is concerned, therefore, very little more is known about its possibilities than was shown by the work of Milovanov (1932), Rodolfo (1934, a, b, c,) and Rodin & Lipatov (1935). These workers demonstrated that semen could be obtained from the boar quite simply by means of a dummy sow and artificial vagina. In addition, experiments on a number of State farms in Russia between 1931 and 1934 showed that a good conception rate of 70 per cent. could be expected when sows were inseminated on the second day of heat with 100 to 150 ml. of semen diluted in the ratio of about 1 : 3. As far as can be gathered, only fresh semen was used and there is little information available concerning the development of suitable conditions for storing the sperm. It is difficult to ascertain to what extent artificial insemination in pigs is being applied in Russia at the present time and very little work has been done elsewhere. Some small scale experiments have been carried out in the United States (McKenzie, Lasley & Phillips, 1939, Wiggins Grummer & Casida, 1951) and there are a few reports of work in some other countries—Bonadonna (1938), Abbondanza (1940), Götze (1949), Laurans & Mauleon (1952) but the most important recent contribution in this field has come from the Zootechnical Experimental Station in Chiba, Japan (Ito, Niwa, Kudo & Mizuho, 1948). In general, however, this later work confirms the earlier results of the Russians. The technique of artificial insemination in the pig is feasible, but there have been no developments on any large scale and no experiments have hitherto been carried out in Great Britain.

It is difficult to explain why the pig should have been neglected for so long. It is certainly not through any lack of knowledge concerning the physiology of reproduction in this species as a great deal of work on sex physiology in sows was done around about the 1920's by Corner, and by McKenzie and co-workers; and, since this time, there have been numerous papers on problems of reproduction in swine (Nalbandov, 1950, and Burger, 1952). There is also a considerable body of information on the semen of the boar (Wallace, 1949, and Glover, 1955).

If economic considerations play any part in the development of scientific techniques, there appears to be as good a case for the development of artificial insemination in pigs as there is in cattle. In this country at least, pig breeding constitutes a large part of our agricultural production. Moreover, many of the pigs which are kept for commercial purposes are on small farms, which is also the case with the dairy cattle population. Profitable pig farming depends almost entirely on the production of high quality pigs and it is generally realised that breeding plays as important a rôle as management in achieving this end.

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responsible can be eliminated. This type of investigation work, together with the fundamental research carried out in the laboratory, should be able to provide the answer to most of the problems encountered.

A rather more difficult aspect of A.I. for pigs is the inability of many owners to detect oestrus in their sows. In order to obtain good results it is essential to inseminate on the second day of oestrus and failure to detect its onset can result in lack of success.

There is little doubt that the technique in the pig is infinitely more difficult and complicated than in the bovine, and for this reason alone it is unlikely that developments will proceed at anything like the same rate as in cattle. This may well be a blessing, for it will give sufficient time for advances in techniques to go hand in hand with developments to ensure the use of progeny tested boars at A.I. centres.

The recent Howitt report recognises and lays stress on the possibilities of A.I. in pigs, and there is no doubt at all that the veterinary surgeon has a considerable part to play in implementing these possibilities.

The emphasis on quality is reflected in the very high prices tnat some farmers are prepared to pay at the present time for valuable breeding stock and the cost of a valuable boar is generally outside the range that most small pig farmers can afford. It would be highly desirable, therefore, for farmers to be able to obtain the services of a good boar from an artificial insemination centre. Although five new Boar Progeny Stations are being established at the present time, the number of boars proved to be of good breeding quality will be inadequate to supply the demand unless they can be made to produce more offspring. In addition, artificial insemination would tend to reduce the movement of breeding pigs from farm to farm and diminish the likelihood of spreading diseases.

During the past year, experiments were started at these laboratories in order to explore the possibilities of artificial insemination in pigs. The work is still in its early stages, and in this paper the general position will be reviewed, and the experimental results achieved so far will be described.

Semen

The semen of the boar has been described in detail by a number of authors (Rodolfo, 1934, a and c, Nesmejanova, 1936, McKenzie, Miller & Bauguess, 1938, Wallace, 1949) and information on the form of *ejaculation* and composition of the semen is summarised in a recent review by Glover (1955). The main points of interest as far as artificial insemination is concerned are as follows:—

1. Method of Collection

The semen can be collected very easily by means of an artificial vagina. In considering the various designs which have been described, it appears that it is far less important to observe a strict control of temperature or pressure in the artificial vagina for the boar than it is for the bull or ram. The simplest type which has been used consists merely of a long piece of thin rubber tubing which is attached at one end to a large key ring and at the other to the collecting vessel. The penis is directed into the rubber tube and during the course of ejaculation a pulsating pressure is maintained on the outside by hand (McKenzie, 1931). A shorter model, fitting only over part of the penis, is used in Japan (Ito *et al.*, 1948). In these laboratories we have preferred a modification of the Russian type which is rather similar to that which is used for the bull (Rodolfo, 1934a). The construction of this artificial vagina is shown in Fig. 1. Before use, the space between the outer casing and the liner is filled with warm water at 40° C. and the inside of the liner is greased with a suitable lubricant such as petroleum jelly. When the vagina is warm, the water is tipped out and the pumping apparatus attached. The space between the outer casing and the liner is then filled with air by pumping bulb A, which contains non-return valves, and the pressure on the liner should be adjusted until the two inner surfaces are meeting quite tightly. The penis is deflected into the artificial vagina and during the course of ejaculation a continuous pulsation is maintained by pumping bulb B, which is a simple bulb with no valves. The collecting vessel should have a capacity of about 500 ml. and it should be designed with a wide neck, but it is generally unnecessary to insulate it except in very cold weather. The length of the artificial vagina described is about 30 cm. and this is suitable for most boars. However, if the penis comes right through the artificial vagina and into the cone, it may take rather a long time to obtain the semen and in this case a longer model should be used. On the other hand, if the vagina is too long, it tends to become blocked with the gelatinous secretions in the semen which interferes with collection. Rodin (1940) considered that it was not necessary to apply pulsating stimuli along the

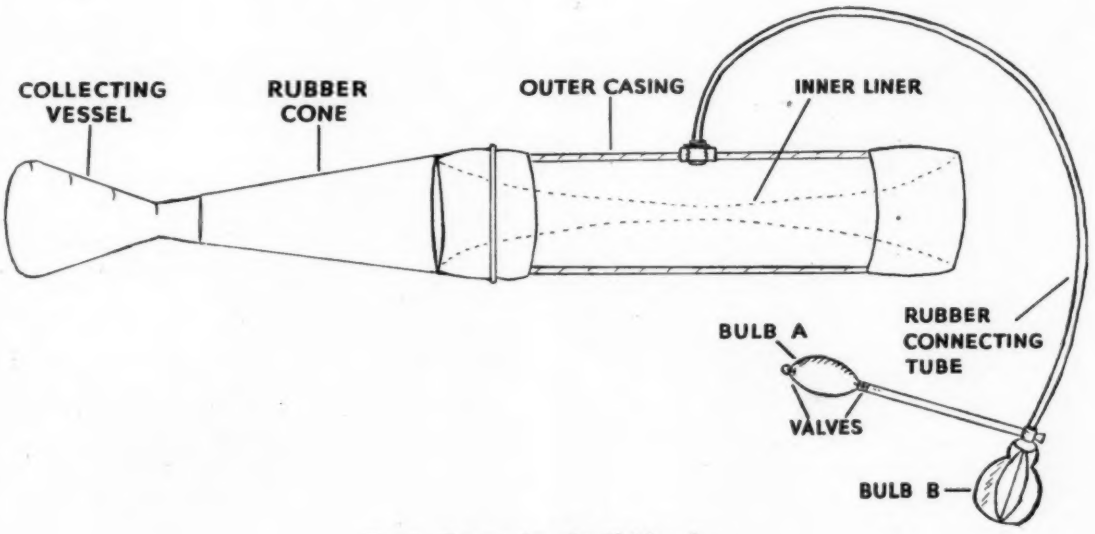

FIG. 1.—Construction of artificial vagina.

whole length of the penis, but that ejaculation occurred only when the head of the penis and an area about 30 cm. from the head was stimulated. Panyseva & Kozenko (1940), on the other hand, state that pulsations on the artificial vagina during service had no effect on the quantity or quality of semen produced. It has also been suggested that it is unnecessary to grease or warm the artificial vagina since the copious secretions from the boar's urethral glands supply sufficient lubrication. Nevertheless, although it may be possible to collect semen with very crude apparatus, it is probably desirable to use a type of artificial vagina similar to that described above when regular collections are being made from boars over long periods of time.

When semen is collected on a farm, it is generally satisfactory to allow the boar to mount a sow which is on heat. The sow should be full on heat in order to stand sufficiently quiet for a complete collection to be made. For routine collections at an artificial insemination centre, however, it is preferable to use a dummy sow and most boars will take quite readily to a dummy even if it bears very little resemblance to a pig. The type of dummy used at these laboratories is shown in Fig. 2. It is made from a metal

FIG. 2.—Dummy sow.

framework padded on the outside with sacking, and its dimensions are, length 90 cm., height 60 cm., and width 30 cm. A portion of the side is cut away at the back allowing the artificial vagina to be held up inside the framework which is better than deflecting the penis to one side. Figs. 3 and 4 show a collection being made. The artificial vagina may be fixed inside the dummy (Götze, 1949, and Glover, 1955), but it is less manoeuvrable and there is little advantage to be gained except that it makes it simpler for one person to collect.

Occasionally, boars will show very little interest in a dummy and in such cases it is often possible to train them to mount by means of association. If, for instance, a boar is allowed a number of natural services in a certain place, he will tend to associate that place with mating and when a dummy is substituted for a sow on heat he will, as a general rule, mount it quite readily.

The boars used for artificial insemination at these laboratories are kept in " fold " units, Fig. 5. They are either tethered or loose at the front of the fold and in this way they get plenty of exercise and can use the covered house for sleeping quarters. The dummy is kept in the enclosed area at the back of the fold and the boar is admitted to this area only when a semen collection is to be made.

FIG. 5.—Housing of boar used for artificial insemination.

Semen can also be collected from the boar by means of electrical stimulation (Dziuk *et al.*, 1954) but there are no records of a complete ejaculate having been obtained by this means.

2. Composition of Semen

The chief characteristics of the semen of the boar are its very large volume and rather low sperm density as compared with that of most other animals. There are wide variations in the composition of the ejaculate between different boars and from time to time in the same boar. Thus, the volume of the whole ejaculate may range from between 100 and 500 ml. in mature animals, but the most common amount is in the region of 200 ml. Similarly, the concentration of the sperm may vary between about 10,000 and 1,000,000 per μl. with an average value of about 100,000 per μl. These fluctuations in the composition of the semen could be expected from the results of work on other animals, and there appears to be no direct relationship between semen volume and sperm density (Glover, 1955) or between volume and the total number of sperm (Rodolfo, 1934a). Nevertheless, it is clear that the number of sperm produced by the boar in a single ejaculate is very high indeed; an average value would be about 2×10^{10} sperm, which is 5 or 10 times as many sperm as would be expected in a single ejaculate from a bull.

Owing to the low sperm concentration in a normal ejaculate, it is rarely possible to observe any wave motion in the semen when it is examined under the microscope or by means of an impedance bridge as designed by Rothschild (1949). A good ejaculate,

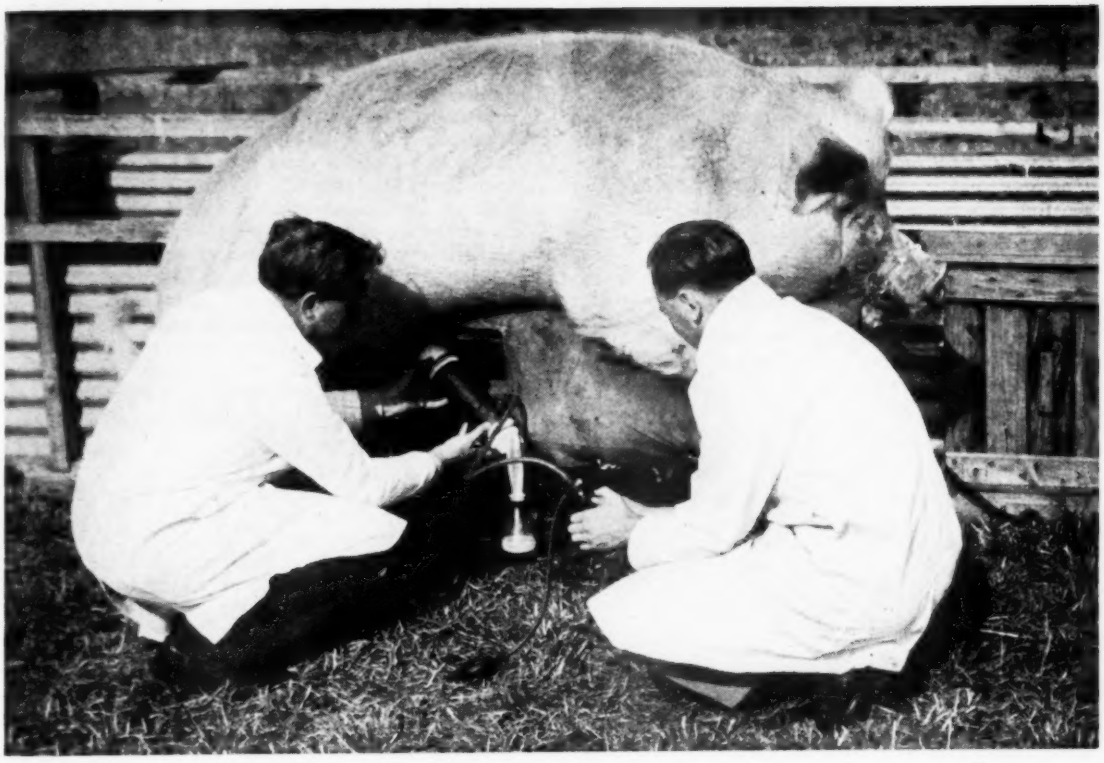

FIG. 3.—Semen collection.

Fig. 4.—Semen collection.

however, should contain a large proportion of highly active sperm. Wave motion can be demonstrated if the semen is concentrated by centrifugation, or if it is collected in fractions and the high density sperm fraction only is examined. Live and dead sperm can be distinguished by staining techniques using opal blue and eosin (Lasley & Bogart, 1944a), or nigrosin and eosin (Hancock, 1951).

The metabolism of boar sperm has been studied by Winchester & McKenzie (1941, a, b, and c), and the *p*H of freshly collected semen is in the range of 7.3 to 7.9 (McKenzie *et al.*, 1938).

Little work has been done on the morphology of boar sperm. According to Makhovka (1932) and Ito *et al.* (1948), the length of the sperm head is about 8 μ and its width about 4 μ, and the total length of the sperm is about 56 μ. McKenzie & Phillips (1933) noticed that the most common abnormalities which occurred in semen were small or tapering heads and enlarged mid-pieces. Sperm with coiled tails also appear and it is quite common to find a proportion if immature sperm with protoplasmic drops (Ito *et al.*, 1948). The semen of healthy fertile boars may contain up to 10 per cent. of abnormal sperm, but if the proportion of abnormalities is much above 15 per cent., the boars may be sub-fertile and produce small and weak litters (McKenzie & Phillips, 1933). Herrick (1949) considered that not more than 25 per cent. should be abnormal. Since artificial insemination has not been developed, however, there has been very little work on the relationships between semen characteristics and fertility.

3. The Pattern of Ejaculation

The process of ejaculation in the boar is prolonged and it may take anything from 3 to 20 minutes to complete a full ejaculate, but, as described by McKenzie *et al.* (1938), it follows a very definite pattern. As soon as the boar has mounted the dummy, the penis is thrust vigorously into the artificial vagina. The preliminary thrusting motions may last several minutes and they are accompanied by the secretion of an almost clear fluid which is rather sticky and contains a certain amount of jelly-like material. Soon, however, the thrusting ceases, the boar becomes quiet and the volume of semen ejaculated is greatly increased. The fluid at this time is quite thick and white and contains a small proportion of gel in lumps like tapioca. Finally, while the boar is still quiet, the fluid ejaculated becomes almost clear again and it is accompanied by a large quantity of the tapioca-like lumps. If the collecting vessels for the semen are changed at intervals during the course of ejaculation, it is possible to distinguish three quite distinct fractions which correspond to the phases described above (Rodolfo, 1934a, McKenzie *et al.*, 1938). The first fraction contains no sperm and is generally termed the " pre-sperm " fraction; the second contains a very high concentration of sperm and is termed the " sperm-rich " fraction; the final fraction, as the fluid becomes clear again, contains a much lower concentration of sperm and is termed the " post-sperm " fraction.

When semen collection is continued after one full wave of ejaculation has been completed, the boar will generally produce another ejaculate which follows exactly the same pattern as the first. In this case he will start again by vigorous thrusts of the penis followed by the quiescent period, and produce three fractions of semen, although the concentration of sperm in the sperm-rich fraction will be lower than that in the first ejaculate. It is not uncommon, however, for a boar to produce two or even three ejaculatory waves during one quiescent period. If this occurs, the sperm-rich fraction in the second ejaculatory wave follows directly after the last fraction containing the gelatinous lumps in the first ejaculatory wave.

4. The Contribution of Accessory Glands to the Semen

The number of sperm in the epididymis of the boar is very high indeed and the semen is very concentrated (Novoseljcev, 1951). It follows, therefore, that the great bulk of the ejaculate is made up from secretions of the accessory glands. By comparing the sperm concentration in epididymal fluid with that in ejaculated semen, it has been calculated that the contribution of the epididymis to the whole ejaculate is only between 1 and 5 per cent. McKenzie *et al.* (1938) systematically removed the various accessory glands from a number of boars and observed the difference which this caused in the composition of the ejaculate. They found that the seminal vesicles contributed about 20 per cent., the Cowper's glands about 15 per cent., the prostate and urethral glands about 62 per cent. and the epididymis about 3 per cent.

Another approach to this problem is through the chemical analysis of semen and accessory gland secretion. Mann (1948 and 1951), Humphrey & Mann (1949), and Mann & Leone (1953) have shown that boar semen, in addition to inorganic constituents, contains fructose, citric acid, meso-inositol and ergothionine. Moreover, these four constituents are found only in the secretions of the seminal vesicles. By estimating the concentration of fructose, citric acid and ergothionine in ejaculated semen and in seminal vesicle secretion, it was deduced that the contribution of the seminal vesicles to the whole semen was about 20 per cent. (Mann & Glover, 1954) which confirms the earlier reports of McKenzie *et al.* (1938).

If a fractionated semen collection is analysed, it appears that no seminal vesicle secretion is contained in the pre-sperm fraction, but that it occurs in the sperm-rich fraction, and in greatest abundance in the post-sperm fraction (Glover & Mann, 1954). According to McKenzie *et al.* (1938), the pre-sperm fraction is composed of secretions from the prostate, urethral and Cowper's glands; all the secretions from the epididymis will be in the sperm-rich fraction and this is followed by secretions from the seminal vesicles and Cowper's glands, some of which will be in the sperm-rich fraction, but most in the post-sperm fraction. There is, of course, a certain amount of overlapping between all fractions.

The gelatinous material constitutes about 20 to 30 per cent. of the whole ejaculate.

5. The Chemistry of Semen

The copious volume of the semen of the boar has provided admirable material for the attention of chemists. Notable contributions in this field have been made by Nesmejanova (1936 and 1940), McKenzie *et al.* (1938), Mann (1948, 1951, and 1954), Mann & Leone (1953), Humphrey & Mann (1949) and Glover & Mann (1954). In the 1930's analysis was restricted mainly to the mineral constituents in whole semen and in the various fractions. Mann and co-workers, in addition to studying the inorganic constituents, made a comprehensive investigation of the organic compounds occurring in the semen. The concentration of mineral constituents varied little from one fraction to another, and, in the section above, reference has already been made to some of the organic constituents which occur in the semen and notably in the seminal vesicle secretion. The main point of interest which emerges from this work is that boar semen appears to differ from that of most other farm animals in having rather a low concentration of fructose, but in containing a large quantity of ergothionine and meso-inositol.

The physiological significance of the various constituents of the seminal plasma is unknown and whether or not they play an important part in the process of fertilisation is being investigated at the present time. Doubt as to the importance of the accessory secretions is brought about by the observation of McKenzie *et al.* (1938), that boars with all their accessory glands removed were as fertile as normal animals. It is possible that the large volume of semen assists in the transport of sperm to the site of fertilisation and it is certainly true that when pigs are killed soon after mating the uterine horns are found to be full of semen (Mesnil du Buisson & Dauzier, 1955; Mann, Polge & Rowson, 1955). The gelatinous material generally forms a plug in the cervix which may prevent the loss of semen immediately after mating, but the absence of a plug does not necessarily cause a reduction in the conception rate.

Frequency of Semen Collection

At the present time, there is little information available concerning the extent to which a boar can be used over a long period of time without affecting semen production, or the number of semen collections which can be made per week in order to obtain the maximum number of sperm. These are obviously important points in the organisation of an artificial insemination service. Rodolfo (1934a) stated that a boar should not be used intensively until he is at least two years old and even then, if he is used for mating once a day, this should not be continued for more than two consecutive days and it should be followed by a two-day rest. Less semen is produced by boars if they are used twice per day with a one-day rest period in between, than if they are used once each day. McKenzie *et al.* (1938) examined the effect of frequency of ejaculation over a 7- to 10-day period on semen characteristics. They found that in ejaculates collected at 48-hour intervals or longer, the volume of semen produced remained above 200 ml., the concentration of sperm above 1×10^5 per μl. and the total number of sperm above 20×10^9; the number of abnormal sperm did not exceed 10 per cent. and the sperm retained their capacity for motility during storage at 10° to 12° C. for five or more days. Repeated ejaculations at intervals of 24 hours or less, reduced semen production below these values, increased the proportion of abnormal sperm and reduced the length of time for which the sperm survived during storage. Two out of three boars, used at 12-hour intervals, temporarily lost their desire to mate after the third or fourth collection.

The amount of use to which a boar can be put will probably vary in different individuals and breeds. One Large White boar, between one and two years old, kept at these laboratories for the purpose of artificial insemination, has been subjected to regular twice-weekly semen collections for one year (semen collected at three- to four-day intervals). In most cases, two ejaculates have been obtained at each collection. The quantity and quality of the semen has not diminished over this period and the fertilising capacity of the semen has remained high throughout.

On the information available, therefore, it would appear that it is possible to use a boar at least two or three times per week and, on this basis, one boar should produce not less than 500 ml. of semen per week with an average sperm concentration of about 1×10^5 per μl. or, in other words, 5×10^{10} sperm per week.

Preservation of Semen

The development of artificial insemination in any species depends to a large extent on being able to preserve the semen *in vitro* for several days without causing a serious reduction in the fertilising capacity of the sperm. Relatively few experiments have been carried out on the storage of boar semen, but in general it has proved more refractory than that of some other animals at least in so far as the maintenance of fertilising capacity is concerned. It has often been stated that under storage condition *in vitro*, boar sperm fail to survive as well, for instance, as bull or ram sperm (Glover & Mann, 1954; Glover, 1955). In fact, there is very little evidence to support such a statement and, as will be described later, at certain temperatures, boar sperm will maintain their capacity for motility for longer periods of time than either bull or ram sperm kept without special diluting fluids.

1. Undiluted Semen

In the first place, it is important to make a clear distinction between what will be termed here " whole semen " and " fractionated semen." Whole semen is defined as the complete ejaculate from which the gelatinous lumps have been removed by filtering the semen through a fine gauze. Fractionated semen is defined as the sperm-rich fraction only, which, as described earlier, is obtained by changing the collecting vessels during the course of ejaculation. The gelatinous lumps are removed from the semen soon after collection because if they are left, they quickly absorb a large part of the liquid and swell up until the semen has become almost completely gelatinised. Apart from the gelatinous fraction, therefore, whole

semen contains the majority of the accessory gland secretions and fractionated semen contains very little. Ito *et al.* (1948), found that these two parts of the semen behave very differently at various storage temperatures and results obtained in these laboratories substantiate their reports.

When whole semen is kept at body temperature in the presence of air, the sperm maintain a high degree of motility for six to eight hours, but after this time they soon become immotile and die. On the other hand, when the semen is cooled to a temperature between 15° and 20° C. the sperm become almost immotile within the space of two to three hours. In this condition, however, they are not dead and they can be reanimated quite quickly by shaking the semen with air and by warming at 37° C. After storage at 15° to 20° C. for one day, it takes rather longer to reanimate the sperm. For instance, semen kept in test tubes for 24 hours shows very little motility after warming at 37° C. for 15 minutes, but if the semen is shaken and warmed for two hours, almost complete motility is restored and it is practically indistinguishable from freshly ejaculated semen. A high degree of motility can be demonstrated by warming at 37° C. in semen kept at 15° to 20° C. for two or three days, but after this time the proportion of sperm which revive on warming is quickly reduced. The period for which boar sperm will survive at 15° to 20° C. is no shorter than that for bull or ram sperm. The fact that it takes two hours warming and shaking to demonstrate their motility, although it has been noticed by several authors (Ito *et al.*, 1948; Noll, 1950), may have led to a number of erroneous conclusions that the sperm were dead.

By contrast, when whole semen is cooled to temperatures below 10° C., very few of the sperm can be reactivated by warming to 37° C. Temperatures below 10° C. appear to be progressively worse for sperm survival and after 24 hours' storage at 5° C., not more than 5 to 10 per cent. of the sperm can be reactivated by warming. At first it was thought that this behaviour might reflect an extreme sensitivity to thermal shock and that the semen had been cooled too rapidly. Even in samples which were cooled very slowly over six hours from 20° to 5° C., however, very few sperm were alive after 24 hours' storage.

Fractionated semen behaves differently; the length of time the sperm survive is increased as the temperature is reduced. At body temperature or at 15° to 20° C. the survival of sperm in fractionated semen is similar to that in whole semen, but if fractionated semen is cooled to 5° C., the sperm will retain their capacity for motility for very long periods of time. In some samples, very good activity of the sperm can be seen on warming to 37° C. after 8 to 10 days' storage at 5° C. Fractionated semen is also more resistant to thermal shock than whole semen, but, as with whole semen, it must be shaken with air and warmed for about two hours in order to demonstrate the motility of the sperm. The period of survival of boar sperm in fractionated semen kept at 5° C. is considerably longer than that of bull sperm kept in undiluted semen at the same temperature.

These observations raise several interesting problems which are being investigated at the present time. In the first place, there must be an interesting mechanism involved in the reactivation of stored boar sperm since it takes considerably longer to reactivate stored boar sperm than it does to reactivate stored bull or ram sperm. In addition, it appears that shaking the semen with air is as important as warming, since samples of semen which are kept under nitrogen cannot be reactivated unless oxygen is admitted. Secondly, there is the discrepancy between the survival of sperm in whole semen and in fractionated semen at 5° C. In this case, it would appear that either the accessory secretions are harmful to the sperm at low temperatures, or the dilution of the sperm reduces their capacity for survival. However, these findings do not agree with those of Lasley & Bogart (1944b) who compared the behaviour of ejaculated and epididymal boar sperm in their ability to survive at 0° C. Whereas they found that ejaculated sperm did not survive at 0° C., epididymal sperm or epididymal sperm suspended in seminal plasma survived at 0° C. for long periods. It was concluded, therefore, that the reduction in the storage potentialities of ejaculated sperm as compared with epididymal sperm was associated with changes in the sperm themselves rather than with changes in their environment.

2. Diluted Semen

The addition of suitable diluting fluids to bull semen increases greatly the length of time for which the sperm can be kept alive *in vitro*. The yolk-phosphate buffer devised by Lardy & Phillips (1939) and the yolk-citrate buffer devised by Salisbury, Fuller & Willett (1941) have been pre-eminently successful for the storage of bull semen, and it is largely owing to their use that artificial insemination in cattle has been able to expand so rapidly.

Several diluting fluids have been added to boar semen in an effort to prolong the active life of the sperm *in vitro*. So far, nothing has been discovered which will preserve boar semen for so long as bull semen in the diluting fluids mentioned.

Milovanov (1934) and Selivanova (1934) suggested that diluting fluids containing a high proportion of electrolytes were harmful to boar sperm as it was considered that these destroyed the lipid capsule surrounding the sperm head. The resistance of boar sperm to the destructive effects caused by adding increasing quantities of a 1 per cent. solution of sodium chloride to the semen was also found to be much less than that of bull or ram sperm. The diluents used for the storage of boar semen in Russia, therefore, consisted mainly of a solution of glucose (about 5 per cent.) with the addition of small quantities of sodium sulphate or sodium potassium tartrate and peptone (Anderson, 1945). Rimoldi (1947) found that the sperm stored better in these diluents if they were concentrated by centrifugation. Since the introduction of diluents containing egg yolk, however, these early Russian diluting fluids have generally been superseded. Lasley & Bogart (1944b) found that the addition of yolk-phosphate buffer, as used for bull semen, greatly increased the resistance

of boar sperm to thermal shock. In addition, Noll (1950) observed that egg yolk alone, added to boar semen in the ratio of 1 : 2, increased the survival time at 5° C.

In these laboratories we have tested the survival of boar semen in four diluting fluids:—

(a) Yolk-citrate (for composition see Salisbury *et al.*, 1941);

(b) Yolk-phosphate (for composition see Lardy & Phillips, 1939);

(c) Yolk-glucose (composition per 100 ml. = 2 grammes glucose, 70 ml. distilled water, 30 ml. egg yolk);

(d) Yolk-glycine (composition per 100 ml. = 2 grammes glycine, 70 ml. distilled water, 30 ml. egg yolk).

The use of yolk-glycine diluent was suggested by the promising results obtained with a similar medium in work with bull semen (Roy & Bishop, 1954; Roy, 1955).

Both whole and fractionated semen was diluted in varying degrees between 1 : 1 and 1 : 19 with the above diluents and stored at temperatures between 20° and 5° C. In addition, whole and fractionated semen was kept undiluted as a control and the samples were examined at daily intervals for motility at 37° C. The results can be summarised as follows:—

(1) Soon after the addition of the diluents, the motility of the sperm was very good in all samples.

(2) None of the diluting fluids increased the survival of sperm at 15° to 20° C. as compared with the controls, but when added to whole semen, all of them increased the survival of sperm at 5° C.

(3) There was no apparent difference between fractionated and whole semen in any of the diluents or between different degrees of dilution from 1 : 1 to 1 : 19.

(4) Yolk-citrate was the least satisfactory of the diluents examined. The motility of the sperm in this medium was very low after two days at 15° to 20° C. or three days at 5° C.

(5) Yolk-phosphate was slightly better than yolk-citrate, but few sperm were alive in this fluid after four days at 5° C.

(6) The best results were obtained with either yolk-glucose or yolk-glycine and there was no difference between the two. In both, very good motility (60 to 70 per cent. of the sperm active) could be demonstrated after five or six days' storage at 5° C. but after this time the proportion of motile sperm was quickly reduced.

(7) It required less time to reactivate the diluted samples than it did to reactivate the undiluted samples. Thirty minutes' warming and shaking with air was usually sufficient to demonstrate the full motility in diluted semen, whereas it required two hours for undiluted semen.

In general, therefore, it can be said that the addition of these diluting fluids containing egg yolk to whole semen, greatly increased the survival of sperm at 5° C., but even in the best fluids (yolk-glucose or yolk-glycine), the time for which the sperm could be kept alive at 5° C. was not much longer than in undiluted fractionated semen.

3. Preservation of Semen at Very Low Temperatures

Following the discovery that the addition of glycerol to semen protects sperm against the damaging effects of freezing and thawing (Polge, Smith & Parkes, 1949), it has been possible to preserve the semen of several species for very long periods of time in solid carbon dioxide at −79° C. The technique of freezing semen has been widely applied in the artificial insemination of cattle and samples of bull semen have been stored successfully for over a year (Rowson & Polge, 1953).

Several experiments have been carried out on the freezing of boar semen. This work is still in progress, but the results achieved so far should be briefly mentioned.

The sperm are all killed if undiluted boar semen is frozen at −79° C. but the addition of glycerol affords some protection. However, if boar semen is frozen in a similar manner to bull semen (Polge & Rowson, 1952) very few of the sperm survive when it is thawed. This result is hardly surprising, since in all species examined so far, it has been necessary to introduce considerable variations in technique, and the most promising method for freezing boar semen which has yet been developed is as follows:—

The semen is diluted 1 : 1 with a solution containing 2 per cent. of either glucose or glycine and 25 per cent. of egg yolk. It is cooled to 10° to 15° C. and re-diluted with a similar solution containing glycerol so that the final concentration of glycerol in the mixture is between 8 and 10 per cent. by volume. The medium containing glycerol is added slowly in order not to damage the sperm by a sudden change in the osmotic pressure of the diluting fluid and two to three hours later the semen is sealed in glass ampoules and frozen to −79° C. The rate of freezing is similar to that used for bull semen. After semen is frozen by this technique, about 25 per cent. of the sperm revive when the samples are thawed. It is clear that the conditions are far from optimal and much more work requires to be done. One of the most discouraging features is that in the media used, glycerol in a concentration of 10 per cent., which affords the best protection against damage through freezing, appears to be rather detrimental to sperm motility. Future experiments, therefore, should be centred on improving the composition of the medium.

Artificial Insemination

Under natural conditions of mating, the boar inseminates a very large volume of semen directly into the uterus of the sow and at the end of service the cervix is sealed with a gelatinous plug. The duration of oestrus in the sow is generally between two and four days and farmers will often mate pigs twice during one oestrus period in order to obtain the best chance of fertilisation.

In the technique of artificial insemination, therefore, apart from the conditions for storing the semen, there are three main points to consider. First, the volume of semen which should be inseminated and whether it is necessary to insert a vaginal plug. Secondly, the number of sperm which should be used

in order to achieve a normal conception rate. And, finally, the optimum time during the oestrus period in which to carry out the insemination.

It is generally considered that the large volume of semen in the boar assists the sperm to reach the site of fertilisation. Nevertheless, for the purpose of artificial insemination, it seems unnecessary to use as large a volume as a normal ejaculate. Rodin & Lipatov (1935) obtained good results with 100 to 150 ml. of diluted semen, varying the dose according to the size of the pig. McKenzie, Lasley & Phillips (1939), Wiggins, Grummer & Casida (1951) and Ito *et al.* (1948) used 50 ml. and the latter authors also state that if the sperm-rich fraction only is used and the semen is stored for less than 24 hours, 30 ml. is sufficient.

As the gelatinous material is usually removed from the semen before artificial insemination, no vaginal plug can be formed. In the experiments of Ito *et al.* (1948) no special precautions were taken in order to avoid the wastage of semen following insemination, but Wiggins *et al.* (1951) inserted a small wad of moistened cotton wool into the vagina when the catheter was withdrawn.

Little is known about the smallest number of sperm which can be used for insemination in the pig in order to produce a normal litter size, but this point is of considerable importance in the organisation of an artificial insemination service when estimating the degree to which the semen can be diluted. Wiggins *et al.* (1951) varied the number of sperm inseminated and it is interesting to note that some eggs were fertilised in pigs when as few as 2×10^7 sperm were used (0.1 ml. of fresh semen diluted to 50 ml. with a modified Kreb's solution). For a normal litter size, however, considerably more sperm should be used. Ito *et al.* (1948) suggest that 5×10^9 sperm are necessary when the semen is less than 24 hours old and that the number should be increased if the semen is kept for a longer period.

By contrast, there has been a large amount of work done on the best time to mate pigs during the oestrus period, and the time of ovulation is quite well established (Corner & Amsbaugh, 1917; McKenzie, 1924, 1926, 1932; McKenzie & Miller, 1930; McKenzie & Terrill, 1935; Krallinger & Schott, 1933; Burger, 1952; Hammond, 1952). Ovulation generally occurs between 18 and 54 hours after the onset of heat and the most common time is between 24 and 36 hours. Burger (1952) has reviewed the past literature on the time of ovulation and his own experiments carried out in South Africa are of considerable interest. He found that, although there were wide individual and breed differences, there appeared to exist a relationship between the time of ovulation and the length of the oestrus period. In Large Whites, for instance, the average length of oestrus was 48 hours and the time of ovulation was between 18 and 36 hours after onset; in Large Blacks, the average duration of oestrus was 63 hours and ovulation occurred between 42 and 54 hours after onset. Using natural mating, groups of pigs were served at 12-hourly intervals from the beginning of heat. The proportion of matings which resulted in fertilisation was similar in Large Whites from 0 to 24 hours and in Large Blacks from 0 to 36 hours. Mating at a later time resulted in a highly significant decrease in the conception rate. It appears, therefore, that so long as mating is carried out before ovulation, there is an equal chance of fertilisation occurring even if the sperm have to remain in the oviducts for 36 to 40 hours before the eggs are shed. On the other hand, once the eggs have been ovulated, the length of time they remain fertilisable is fairly short. It is worth noting, also, that in Burger's experiments, the proportion of eggs which were fertilised as a result of successful matings was similar at all stages of the oestrus period. In other words, if fertilisation does occur, the majority of the eggs will be fertilised regardless of the length of time between mating and ovulation. However, the proportion of fertilised eggs which failed to develop was increased when services were delayed until the latter part of heat, but embryonic mortality due to fertilisation of the eggs by " stale " sperm did not appear to occur. Litter size could be smaller, therefore, when sows were mated late in heat.

Although Burger found that the conception rate was the same in pigs mated on the first or second day of heat, it is interesting to note that if pigs are mated on the first day of heat with a white boar and again on the second day with a black boar, the majority of the offspring will be black. On the other hand, if they are mated on the second day with a white boar and on the third day with a black boar, the majority of the offspring will be white (Haring, 1937). This substantiates the view that mating should take place before ovulation, but it would also indicate that, although the sperm may be able to live in the female reproductive tract for 40 hours or more, sperm inseminated nearer to the time of ovulation will stand a better chance of fertilising the eggs than the " stale " sperm.

In artificial insemination, therefore, when the number of sperm inseminated will be smaller than that in a normal ejaculate, it would seem logical to carry out the insemination about 24 hours after the onset of heat.

1. Technique of Insemination

The instruments used for artificial insemination in the pig are very simple. They consist of a long catheter which can be inserted deep into the cervix and an apparatus for injecting a large volume of semen. Suitable catheters have been made from glass, ebonite, or rubber, and Hudjakov (1936) suggested that a slightly curved catheter was the best. For injecting the semen, a large capacity syringe may be used and Ito *et al.* (1948) devised a wide-bore catheter fitted with a plunger. The method most often used in Russia was to attach to the catheter a large bottle containing the semen, which was then held above the pig's back, allowing the semen to flow into the uterus by gravity. The apparatus used at these laboratories is shown in Figs. 6 and 7. The catheter, which is about 45 cm. long and 1 cm. in diameter, is made from rubber " pressure " tubing and tapered at one end. The pump for injecting the semen works on the principle of an infusion apparatus. The bottle which holds the semen is 100 ml. in capacity and the air bulb for injection is attached

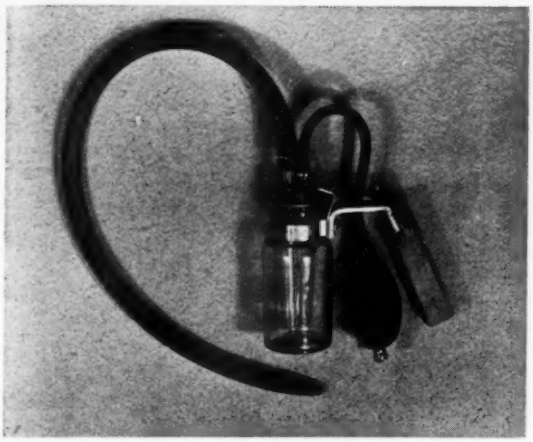

FIG. 6.—Apparatus for artificial insemination.

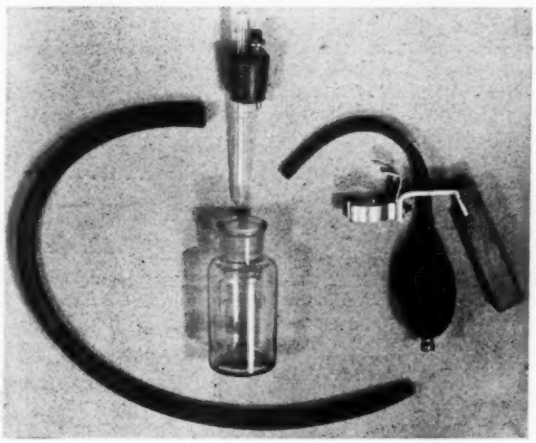

FIG. 7.—Apparatus for artificial insemination.

to a handle which clips on to the neck of the bottle and secures the cork in place. The whole apparatus can be easily dismantled for sterilisation.

The procedure for insemination is shown in Figs. 8 and 9. When a pig is in "full" heat, she will stand quite quietly for insemination with her head down and back arched. It is generally unnecessary to have any form of restraint, but it is sometimes helpful to press on her back. The catheter should be greased and inserted as far as possible into the cervix and if it is pushed up towards the back-bone it will avoid any possibility of piercing the bladder. When the catheter is in place, the lips of the vulva are held together with a small wad of cotton wool and the semen is injected quite slowly. If the semen is cold, it will often be forced back from the uterus and it is advisable, therefore, to use semen warmed at least to 20° C. After the catheter has been withdrawn at the end of insemination, the wad of cotton wool is inserted into the vagina and this helps to prevent the semen from flowing back.

2. Results from Artificial Insemination

For routine insemination at these laboratories, the whole ejaculate was collected from boars and immediately brought to the laboratory where the gelatinous material was removed by filtering through a fine gauze. After straining, the semen was allowed to cool on the bench for about 30 minutes until the temperature reached 25° C. A small sample was put aside for examination and the remainder was then diluted with yolk-glycine medium (for composition see page 69, col. 1). Samples of semen were diluted to varying degrees between 1 : 1 and 1 : 19 and in addition antibiotics were sometimes included in the diluting fluid in the proportion of 500 I.U. of penicillin and 500 I.U. of streptomycin per ml. of diluent. Laboratory examination included an estimation of the proportion of living sperm in undiluted and diluted semen and also an estimation of the sperm concentration by counting in an haemocytometer.

If the semen was not used for insemination within two hours following dilution, it was cooled in the refrigerator and kept at 5° C. until required.

The majority of inseminations were carried out with semen stored for either two to six hours or 24 to 30 hours, but a small number of experiments was done with semen kept *in vitro* for longer periods. The pigs were Large White, Essex or Cross-bred sows and gilts and they were tested regularly for oestrus with a vasectomised boar and inseminated once only on the second day of heat. 100 ml. of diluted semen was used for gilts and 200 ml. for sows. If the pigs became pregnant, they were either killed between four to six weeks of pregnancy or allowed to farrow, and in estimating litter size only normal foetuses at four to six weeks, or the number of pigs born alive, were counted.

The results of these experiments are shown in Tables I to V and they have been arranged according to the number of sperm inseminated, the age of the semen, and whether the inseminations were in gilts or sows. The number of sperm inseminated was calculated from the concentration of sperm in the original sample of semen and the degree of dilution. For instance, in the group of gilts receiving between 1.1 and 2.0 $\times$ 10^9 sperm, the semen was generally diluted in the ratio of 1 : 19 since the concentration of sperm in the majority of ejaculates was around 2 $\times$ 10^8 per μl., but in more dilute samples of semen the degree of dilution was only 1 : 9. The lowest dilution used was 1 : 1 and the insemination dose with this semen for gilts contained up to 15 $\times$ 10^9 sperm.

A few gilts were inseminated with semen diluted with yolk-glucose medium instead of yolk-glycine (Table VI). For the composition of yolk-glucose medium, see page 69, col 1.

In conjunction with the work on the preservation of semen at very low temperatures, the effect of various concentrations of glycerol on the fertilising capacity of the semen before it was frozen was examined (Table VII). The semen was first diluted with yolk-glycine in the ratio of 1 : 1, cooled in the refrigerator to 10° to 15° C., and then re-diluted 1 : 1 with yolk-glycine containing 10, 15 or 20 per cent. glycerol by volume.

TABLE I—SEMEN STORED FOR TWO TO SIX HOURS

GILTS

Insemination dose—100 ml. diluted semen (1 : 1 to 1 : 19)
Diluent—2 per cent. glycine, 30 per cent. yolk (with or without antibiotics)

Number of sperm inseminated × 10^9	Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Total number of normal foetuses	Average number of foetuses per animal and range	Number of pigs farrowed	Total number of live pigs born	Average litter size per animal and range
1·1–2·0	9	1	11·1	1	11	11·0 —	0	—	— —
2·1–3·0	14	8	57·1	8	75	9·4 (4–12)	0	—	— —
3·1–4·0	20	8	40·0	6	55	9·2 (5–13)	2	21	10·5 (9–12)
4·1–5·0	4	3	75·0	0	—	— —	3	28	9·3 (9–10)
5·1–10·0	26	9	34·6	5	52	10·4 (4–14)	4	42	10·5 (9–14)
10·1–15·0	15	9	60·0	4	42	10·5 (5–16)	5	46	9·2 (8–10)
1·1–15·0	88*	38	43·2	24	239	9·8 (4–16)	14	137	9·8 (8–14)

	Number of inseminations	Number pregnant	Per cent. pregnant
* With antibiotics in diluent	46	23	50
Without antibiotics in diluent	42	15	35·7

TABLE II—SEMEN STORED FOR TWO TO SIX HOURS

SOWS

Insemination dose—200 ml. diluted semen (1 : 1 to 1 : 9)
Diluent—2 per cent. glycine, 30 per cent. yolk (with or without antibiotics)

Number of sperm inseminated × 10^9	Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Total number of normal foetuses	Average number of foetuses per animal and range	Number of pigs farrowed	Total number of live pigs born	Average litter size per animal and range
2·1–5·0	1	1	—	1	8	8 —	0	—	— —
5·1–10·0	9	6	66·7	1	19	19 —	5	63	12·6 (7–18)
10·1–15·0	13	8	61·5	2	31	15·5 (15–16)	6	73	12·2 (8–15)
15·1 +	7	5	71·4	2	19	9·5 (6–13)	3	32	10·7 (9–13)
2·1–15 +	30*	20	66·7	6	77	12·8 (6–16)	14	168	12·0 (7–18)

	Number of inseminations	Number pregnant	Per cent. pregnant
* With antibiotics in diluent	19	15	79·0
Without antibiotics in diluent	11	5	45·5

TABLE III—SEMEN STORED FOR 24 TO 30 HOURS

GILTS

Insemination dose—100 ml. diluted semen (1 : 1 to 1 : 9)
Diluent—2 per cent. glycine, 30 per cent. yolk (with or without antibiotics)

Number of sperm inseminated × 10^9	Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Total number of normal foetuses	Average number of foetuses per animal and range
2·1–5·0	13	4	30·8	4	29	7·3 (4–12)
5·1–10·0	7	1	14·3	1	6	6 —
10·1–15·0	4	3	75·0	3	30	10·0 (9–12)
15·1 +	5	1	20·0	1	9	9 —
2·1–15 +	29*	9	31·0	9	74	8·2 (4–12)

	Number of inseminations	Number pregnant	Per cent. pregnant
* With antibiotics in diluent	15	5	33·3
Without antibiotics in diluent	14	4	28·6

TABLE IV—SEMEN STORED FOR 24 TO 30 HOURS

SOWS

Insemination dose—200 ml. diluted semen (1 : 1 to 1 : 4)
Diluent—2 per cent. glycine, 30 per cent. yolk (no antibiotics). (Over 5 × 10^9 sperm inseminated)

Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Number of normal foetuses	Number of pigs farrowed	Number of live pigs born
9	2	22·2	1	11	1	5

TABLE V—SEMEN STORED FOR MORE THAN 48 HOURS
GILTS
Insemination dose—100 ml. diluted semen (1 : 1 to 1 : 4)
Diluent—2 per cent. glycine, 30 per cent. yolk (with or without antibiotics) (Over 5×10^9 sperm inseminated)

Age of semen	Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Total number of normal foetuses	Average number of foetuses per animal
2 days	18	2	11·1	2	22	11
3 to 5 days	10	1	10·0	1	2	2
	28*	3	10·7	3	24	8

	Number of inseminations	Number pregnant	Per cent. pregnant
* With antibiotics in diluent	14	0	0
Without antibiotics in diluent	14	3	21·4

So far, 35 inseminations have been carried out with semen frozen according to the conditions laid down on page 69, col. 2, and none has resulted in pregnancy.

Discussion

Owing to the rather small number of pigs which has been inseminated up to the present time, it is not possible to draw any definite conclusions from our experiments, but several general indications are evident.

It appears that quite good results can be obtained when sows or gilts are inseminated according to the technique described with semen kept *in vitro* for about six hours.

The figures for inseminations in Tables I and II include several animals which were inseminated two or three times, and some gilts never became pregnant at all. In quoting figures for conception rate, it is the general rule to include only the first insemination for each animal, and if Tables I and II are revised on this basis, the conception rate, especially in gilts, is considerably improved (Table VIII) *(overleaf)*.

It should be emphasised also, that these figures represent an actual pregnancy rate and not a conception rate as assessed on the basis of animals not returning to service. A pregnancy rate of 58 per cent. in gilts and sows is perhaps rather lower than might be expected from natural mating, but it is equally as good as the pregnancy rate obtained in the artificial insemination of cattle.

The effect of decreasing the number of sperm inseminated by increasing the degree of dilution of the semen is shown most clearly in Table I, and these figures would indicate that the conception rate is not altered unless the number of sperm inseminated falls below 2×10^9. As the normal concentration of sperm in boar's semen is between 1 and 2×10^9 per ml. good results could be expected from semen diluted between 1 : 4 and 1 : 9 when 100 ml. is used for insemination.

It is interesting to note, also, that in the range examined, there appeared to be no relationship

TABLE VI—SEMEN DILUTED WITH 2 PER CENT. GLUCOSE, 30 PER CENT. YOLK (no antibiotics)
GILTS AND SOWS
Insemination dose—100 ml. diluted semen (1 : 2 to 1 : 9). (3 to 5×10^9 sperm inseminated)

Age of semen	Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Total number of normal foetuses	Average number of foetuses per animal and range
2 to 6 hours	8	4	50·0	4	44	11 (9–14)
24 hours	3	1	33·3	1	3	3 —
48 hours	2	0	0	—	—	— —

TABLE VII—SEMEN DILUTED WITH 2 PER CENT. GLYCINE, 30 PER CENT. YOLK + VARYING CONCENTRATIONS OF GLYCEROL
GILTS AND SOWS
Insemination dose—100 ml. diluted semen (1 : 3). (5 to 10×10^9 sperm inseminated)

Concentration of glycerol in semen	Age of semen	Number of inseminations	Number of pregnancies	Per cent. pregnant	Number of pigs killed	Total number of normal foetuses	Average number of foetuses per animal and range
5 per cent.	3 to 6 hours	12	7	58·3	7	56	8 (3–13)
5 "	24 "	9	2	22·2	2	2	1 —
7·5 "	3 to 6 "	10	2	20	2	17	8·5 (7–10)
7·5 "	24 "	12	0	0	—	—	—
10 "	3 to 6 "	1	0	0	—	—	—
10 "	24 "	4	0	0	—	—	—

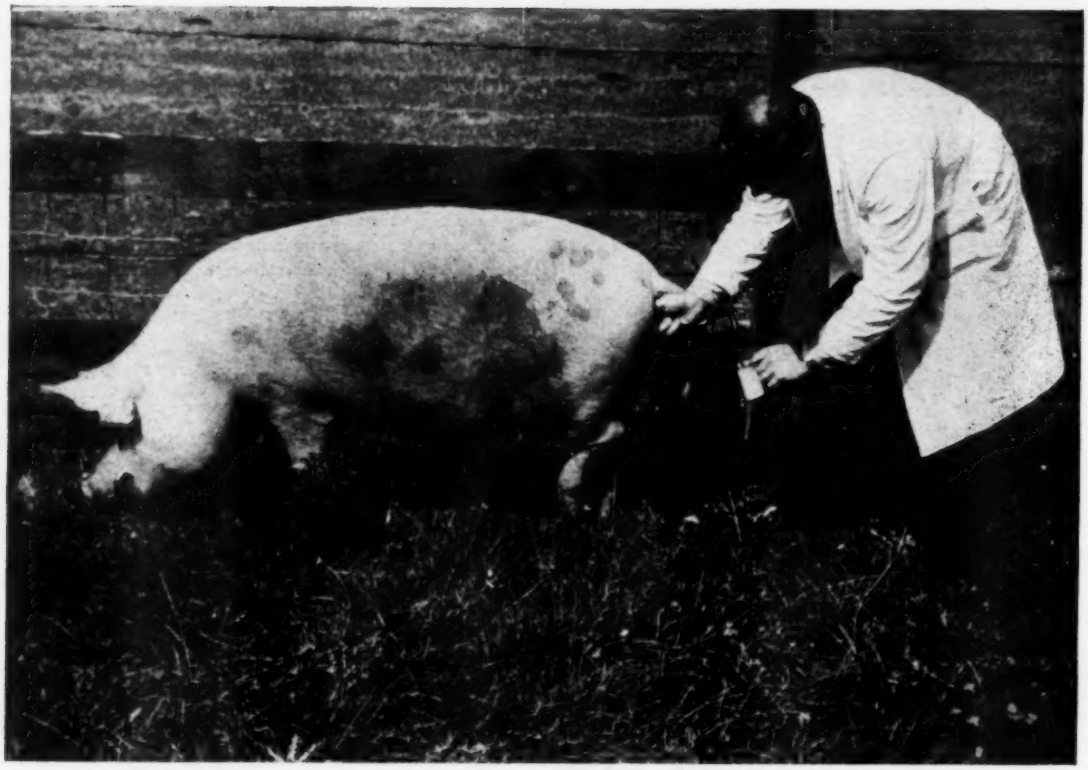

FIG. 8.—Artificial insemination.

between the number of sperm inseminated and the litter size. An average of 9.8 pigs from gilts and 12.0 from sows can be considered normal, the larger numbers in sows being due to a higher ovulation rate.

There seemed to be no difference between yolk-glycine and yolk-glucose as a diluting fluid, but the better results when antibiotics were included in the medium are highly suggestive, although this point will require verification in a larger experiment.

By contrast, results with semen kept for 24 hours or longer were very disappointing. There was a considerable drop in conception rate even when the semen had been kept for one day and very few pregnancies resulted from the use of semen stored for two days or more. On the other hand, the litter size did not seem to be influenced by the age of the semen to such a large extent as the conception rate. There was a reduction of 1.6 in the average litter size

TABLE VIII—FIRST INSEMINATIONS ONLY, FROM TABLES I AND II
(Over 2×10^9 sperm inseminated)

	Number of inseminations	Number of pregnancies	Per cent. pregnant
Gilts	59	32	54·2
Sows	25	17	68·0
Total	84	49	58·3

FIG. 9.—Artificial insemination.

for gilts between first- and second-day semen and this might be significant when larger numbers are involved.

The most striking fact, however, was the difference between the motility of the sperm and their fertilising capacity. In the semen used after one day's storage, the sperm were highly motile and even in samples kept for two or three days, over 50 per cent. of the sperm showed very good activity. This discrepancy between sperm motility and fertilising capacity is much more marked than in bull semen, but it is very similar to results obtained with fowl semen (Polge, 1950).

The figures at these laboratories for conception rate with either fresh or stored semen seem to be rather lower than those quoted by Ito *et al.* (1948) in Japan (Table IX).

TABLE IX

(FROM ITO, NIWA, KUDO AND MIZUHO, 1948)

Hours of storage of semen	Per cent. of conception to the times of insemination
Within 24 hours	76·8
24 to 48 ,,	62·5
48 to 75 ,,	28·6

In these experiments of Ito *et al.* the semen was stored undiluted at 15° C., and the diluting fluid was added to the semen just before insemination. McKenzie *et al.* (1939) also obtained a few pregnancies in pigs inseminated with semen which was stored undiluted, but in their experiment the sperm-rich fraction only was kept at 12° C. and good results were not obtained unless the pigs were inseminated two or more times during one heat period.

As far as the preservation of semen at very low temperatures is concerned, the addition of glycerol to semen in concentrations above 5 per cent. appears to have a detrimental effect on fertilising capacity even when the semen is not frozen. Five per cent. glycerol affords very little protection to the sperm during freezing and thawing, and so far, although pigs have been inseminated with frozen and thawed semen containing quite large numbers of motile sperm, no pregnancies have resulted from the use of frozen semen.

It is clear that, before artificial insemination in the pig can be extended on any large scale, much more work is required on the conditions for storing the semen both at temperatures above and below 0° C. One point which is being considered at the present time is the importance of the gelatinous portion of the semen. In nearly all experiments on artificial insemination, the gel has been removed from the semen in order to facilitate handling *in vitro*. In a very small experiment, however, Bonnadonna (1938) found that none of the pigs which were inseminated with filtered semen became pregnant, but 12 out of 17 became pregnant when the whole semen including the gel was used. Another hint that the gel may have a function other than just sealing the cervix is given from experiments where pigs have been examined soon after mating. If the uterus is cut open within 30 minutes after mating, the gel is found in large quantities not only in the cervix, but also distributed throughout the length of both uterine horns (Mann, Polge & Rowson, 1955). Artificial insemination results would indicate that the gel is not indispensable, but the possibility that its inclusion might improve the conception rate, especially with stored semen, is now being examined.

Conclusion

In conclusion, the present position of artificial insemination in pigs and the future outlook for its development can be summarised as follows.

There are no technical difficulties in the collection of semen or in artificial insemination. Two or three ejaculates may be collected from a boar each week and the semen can be diluted to about 1 : 9 when 100 ml. of diluted semen is used for insemination. Between 50 and 60 per cent. of the pigs should become pregnant to the first insemination and produce normal litters when insemination is carried out on the second day of heat and the semen is used on the day of collection. There is rather a large drop in the conception rate when semen is stored for more than one day and future work should be concentrated on improving the conditions for semen preservation.

As a direct result of the experiments carried out in these laboratories, four cattle breeding centres have recently started an artificial insemination service for pigs on a small scale. Until the conditions for storing the semen have been improved, most of the inseminations are being made with fresh semen, but it is quite possible to organise an artificial insemination service on this basis. When several boars are kept at one centre, semen collections can be made each day without exhausting the boars and, if the semen is used to its greatest advantage, it should be possible to obtain at least 2,000 inseminations from each boar per year. From the economic point of view, the large volume which is used for insemination entails rather high costs for the diluting fluid, but it quite likely that the insemination dose could be considerably reduced. Success will depend to a large extent on the way in which farmers are able to judge the stage of heat of their pigs so that insemination can be carried out at the right time.

Artificial insemination may also be used privately on farms and it should be beneficial especially for the control of contagious diseases.

The present position of artificial insemination in pigs holds out at least as much promise as did artificial insemination in cattle 15 years ago. If there is a similar expansion it is to be hoped that we shall learn from the experience gained in this field. True success will only be obtained if the expansion of artificial insemination goes hand in hand with the development of progeny testing schemes and a service can be offered to the community which is of definite benefit.

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DELIVERY OF "THE RECORD"

Our readers will have read of a dispute in a section of the printing industry, where the trade unions concerned have instructed their members to work to rule. Our own printers are among the many firms thus affected, and it is possible that delays in the production and delivery of the journal may occur until the points at issue are settled.

While every effort will be made to obviate such delays, we ask for the indulgence of readers should their copies be late in arriving.

Degenerations of the Dog Retina

FOLLOWING a paper published in *The Journal of Physiology* (Parry, H. B.; Tansley, K.; Thompson, L. C. (1953). *J. Physiol.* **120.** 28) in which was described the method of determining the electroretinagram in the dog with a demonstration of its value in the early diagnosis of progressive retinal atrophy, Parry published a series of papers under the above title in *The British Journal of Ophthalmology*. Abstracts of these papers are given below, the whole being published together for the convenience of other workers.

I.—Structure and Development of the Retina of the Normal Dog. PARRY, H. B. (1953a). *Brit. Jour. Ophthalmology*. **37.** 385.

From the study of a number of different breeds the author describes the fundus picture as seen through the ophthalmoscope. This includes the non-tapetal area, the varying colour reflections of the tapetum lucidum, the optic papilla and the origin and distribution of the retinal vessels. In 33 per cent. of dogs examined it was observed that physiological cupping of the optic papilla occurred to the extent of 1 - 2 diopters but in the majority it was level with the retina.

The histology of the adult dog retina was found to be typically mammalian. No macula was demonstrated. The author was unable to confirm the suggestion put forward by Zürn that certain breeds which hunt by sight rather than scent have a rod-free fovea with increase in the density of cones. At no time was evidence of a fovea demonstrated; the contention being that this is not necessary in the presence of a tapetum.

The retina in the puppy is not fully developed until it is approximately six weeks old, at which time the ocular media are transparent and visual acuity is complete. It may be eight weeks after birth before the tapetal reflex changes from its dove grey to its more iridescent adult colour.

Post-mortem changes in the retina when fixed at varying periods up to 48 hours after death are described. It would appear that degenerative changes occur within 30 minutes of death and for a true histological picture intra-vital fixation is essential.

(The normal dog fundus has previously been described in detail by the author and co-workers (*Vet. Rec.* **61.** 185).)

II.—Generalised Progressive Atrophy of Hereditary Origin. *Brit. Jour. Ophthal.* (1953). **37.** 487.

By a series of matings the author confirms the view based on previous observations by himself and others that retinal degeneration in Red Irish Setters is hereditary. Fifteen dogs were used in the matings; four males and four females were affected with the syndrome (homozygous); three males and three females were " carriers " (heterozygous) and one male was normal. From 16 litters 93 pups were born of which 58 were affected and 35 were not. The mating of two affected parents always produced all affected pups in equal sex ratio. The mating of an affected parent with a " carrier " produced mixed litters of affected and unaffected pups in approximately equal numbers and equal division of the sexes. The mating of a normal dog with an affected bitch produced no affected offspring.

Changes in the eye are discussed in three stages according to the state of vision.

Stage 1. (Age two to six months.) Night vision was gradually lost, day vision was normal, but with a tendency to an increase in size of pupil. The tapetal reflex became more pronounced and there was some loss of the granular " beading " of the tapetum. Retinoscopy suggested some slight error of refraction as detected by a " swirling " of the supra-tapetal retina. Histologically the most characteristic change at this stage was a progressive loss of rod nuclei.

Stage 2. (Age 3 to 18 months.) Night blindness was complete. The pupillary light reflex became progressively more sluggish as day vision became worse. Examination of the fundus showed that the granular " beading " rod completely disappeared and exhibited large rectangular crystals. The stellulae of Winslow were less marked and the " swirling " of the supra-tapetal retina was increased. During the latter part of this stage a noticeable feature was the reduction in size and number of the retinal vessels. Histologically the main retinal change was the final disintegration of the cones.

Stage 3. (Age six months to four years). Here the pupillary light and eye preservation reflexes were lost. Day vision was completely lost but the dog was able to adjust itself to the state of blindness within a week or two. The optic papilla became irregular in outline and progressively whiter as the arteries and veins became more and more attenuated terminating in their disappearance. During the final stages of the disease cataracts frequently developed and in three animals spontaneous luxation of the lens occurred. In one of these there was such a marked reduction in choroidal pigmentation that the choroidal vessels could clearly be recognised ophthalmoscopically. Histologically, degenerative changes were more or less complete with an almost generalised disappearance of rods and cones.

The author mentions that by ophthalmoscopy and by night vision tests the disease can be detected in the affected dog at six to eight weeks of age. The rate at which the disease progresses varies considerably. All members of one strain were day blind at six to eight months old whilst in others some day vision was present up to three years or over.

III.—Retinopathy Secondary to Glaucoma. *Brit. Jour. Ophthal.* (1953). **37.** 670.

The author discusses two cases of chorio-retinal degeneration. The first was in a three-year-old smooth-coated Fox Terrier which had bilateral luxation of the lens. Both eyeballs were enlarged and intra-ocular tension was increased. The second was in a six-year-old wire-haired Fox Terrier with bilateral glaucoma of unknown origin which over an ensuing period of eight weeks became absolute. In each

case the histological picture, which resembles the pattern of changes seen in man but differs from that seen in the hereditary disease of Red Irish Setters, is described in detail. It is suggested that the retinal degeneration is due to interference with the retinal blood supply by the increased tension.

IV.—Retinopathies Associated with Dog Distemper-Complex Virus Infections. *Brit. Jour. Ophthal.* (1954). **38.** 295.

The author recognises four types of chorio-retinal degenerations which may follow distemper virus infection whether of natural or experimental origin.

1. A peracute retinopathy with the sudden onset of complete blindness.

2. A chronic delayed retinopathy with complete blindness one to two years following infection.

3. " A dystrophy of the cells of the pigment epithelium with or without evidence of other damage to the retina." This type was observed in 19 dogs which acquired a natural distemper infection. It would appear that the dog must be clinically ill for three or four days for histological changes to develop. It is suggested that hypertrophy of the pigment epithelial cells causes secondary pressure atrophy of the outer limbs of the rods and cones.

4. " Sporadic foci of advanced degeneration of the retina, focal retinal atrophy, and sclerosis."

These four types are discussed in clinical and histological detail. However, the average clinician will readily concur with the author when he says that in all probability most cases of blindness associated with distemper infection are due to lesions of the visual apparatus central to the retina.

V.—Generalised Progressive Atrophy of Uncertain Aetiology. *Brit. Jour. Ophthal.* (1954). **38.** 545.

Three cases are described. Two were male Afghan Hounds of a litter of three. The clinical syndrome was identical with that observed in the Irish Setter and histologically the retinal changes corresponded with those seen in the later stages of the disease in Red Setters. In the absence of affected female Afghan Hounds, test matings were made with carrier and affected Irish Setter females. Of 26 puppies born, none was affected suggesting the improbability of the condition being hereditary.

The third case occurred in an eight-year-old yellow Labrador Retriever bitch which went suddenly blind with no previous illness. There was no familial history of blindness in litter mates or offspring. Histological examination of the retina revealed degenerative changes in the walls of the retinal and choroidal vessels which the author found to be characteristic of cases produced by the distemper virus. Dystrophy of the pigment epithelium was, however, absent. The author sounds a note of warning on the necessity for not confusing cases of unestablished aetiology with the hereditary condition.

VI.—Central Progressive Atrophy with Pigment Epithelial Dystrophy. *Brit. Jour. Ophthal.* (1954). **38.** 653.

Under this heading 15 dogs exhibited central progressive atrophy of the retina. The principal clinical feature is that whilst central vision is lost in middle age, peripheral vsion is retained until late in life.

The breeds concerned were Black Labrador, seven; Yellow Labrador, one; Golden Retriever, one; Border Collie, three; Springer Spaniel, one; Irish Setter, one; Collie x Irish Water Spaniel, one. Eleven dogs were brought to the notice of the author because of defective vision. Three stages of the disease are recognised.

Stage 1. Day and night vision normal but hypertrophic pigment epithelial cells could be demonstrated histologically. Later in this stage foci of these cells could be seen with the opthalmoscope as brown pigmentations in the tapetal fundus. They are irregular in outline 0.05 to 0.1 mm. in diameter and are 0.5 to 2.0 mm. apart. The fundus pitcure was otherwise to all intents and purposes normal.

Stage 2. Signs of a central scotoma but peripheral vision good. The central retina became sclerosed but the peripheral retina was still normal. Clinically there was a tendency to dilatation of the pupil; the pupillary light reflexes were sluggish. The tapetal fundus still showed the foci of brown pigmentation. The optic papilla was pale and the vessels of the tapetal fundus were reduced in number.

Stage 3. Peripheral vision was lost. The peripheral fundus underwent atrophy which progressed to complete sclerosis. Clinically the animals were totally blind. Pupils were dilated and there was no light reflex. Refractive errors in the vitreous rendered fundus examination with the ophthalmoscope difficult unless a −10 or −15 lens was introduced into the aperture. The optic papilla was very white although blood vessels were present. The foci of pigment was absent in advanced cases. The fundus vessels were absent or buried within the retina.

In his summary the author divides the syndrome into two types: Type A, familial in Retrievers and Border Collies, possibly due to an inherited abiotrophy; Type B, sporadic, of uncertain aetiology.

VII.—Central Non-Progressive Degeneration Due to an Anomaly of Ganglion Cells and their Axons. *Brit. Jour. Ophthal.* (1955). **39.** 29.

This paper embraces a syndrome seen in a strain of Cocker Spaniels. Four cases were seen in this particular strain. One was an eight-week-old puppy (born in a litter of six of which four were normal and one had a cleft palate). Two were litter mates three years old. The fourth which apparently had had defective vision and cataracts since puppyhood, was three and a half years old and the dam of the puppy. This syndrome differs from the central atrophy described in the author's previous paper in that it is probably congenital; non-progressive and exhibits no pigment epithelial dystrophy. Affected dogs show a central scotoma in infancy due to a degeneration of the optic nerve fibre and ganglion cell layers of the central fundus. In three of the four cases described suture cataracts of the foetal lens nucleus were present. Peripheral day and night vision was retained until middle age. There was some evidence for the disease to be familial but not necessarily hereditary.

Helminths and Husbandry—a Fragment

BY

J. F. MICHEL, C. B. OLLERENSHAW and J. H. ROSE

IT was Darwin, if memory serves us right, who demonstrated the connection between the number of old spinsters living in a district and the yield of red clover seed. The spinsters kept many cats who in turn killed many field mice which were therefore prevented from destroying the nests of the bumble bees who were responsible for fertilising the clover flowers. Though this train of causation is presumably unexceptionable it is not the only one. The yield of clover seed, it is almost superfluous to point out, is determined by large numbers of factors interrelated in a highly complex manner; and cultivators of clover may read without apprehension, in the report of the Registrar General, that 19 women in every 20 do get married. The complexity of ecological relationships has become almost axiomatic. Tinkering with the balance of nature is regarded with misgiving by biologist and layman alike. The transposition of plants or animals from one part of the globe to another has resulted in unpredictable and often distressing consequences. Mother Nature, ruthless, unaccountable, all-powerful, has not ceased to be regarded as an awe-inspiring deity. Until recently, however, man sought to arrange some kind of frontier agreement with Nature. Are there not excellent precedents for bargains or covenants with the deity? The wild forces of Nature were to be restricted to mountain and moorland, to wild and desolate places inhabited by wild creatures and desolate vegetation. But does Mother Nature not reign supreme much nearer home, on Hampstead Heath even? What Londoner promenading at dusk along the Spaniards Road has not sensed something of her mysterious forces?

It is becoming evident that these forces operate everywhere. Agriculture itself is a huge and often ill-fated tinkering with nature. Slow changes are not often noticed, but it is now accepted that the decline of the Greek empire was caused largely by the curious grazing behaviour of the goat. Similarly the present size of Romney Marsh and the low cultural level of the inhabitants of the Weald would seem to stem from a common cause. The fashion changes, the pendulum swings slowly, but there is little new in the realm of human thought. The evil effects of ill-conceived agricultural tinkering with the balance of nature are everywhere apparent. Deserts are advancing, untold areas of once useful farmland the world over, despoiled by erosion, lie derelict. It is not improbable that it will be recognised within a decade or two that even in Britain the force of gravity operates, and that soil when stirred or washed by the rain tends to move downhill.

Prompted by the realisation that man's intervention in nature is often destructive in its effects, a new race of prophets has arisen to preach a modern version of the doctrine of original sin. It appears that in a primitive Golden Age the world looked much as the advertisers of nerve tonics would have us believe. Men were men, muscular, clad in leopard skins, and subsisting on a vegetarian diet entirely compost grown. Animals in this Garden of Eden, sleek and glossy, lived at peace with one another, with their predators and with their parasites. This idyllic state of affairs might well have lasted indefinitely had not man, urged on by the inherent defects of his character—to say nothing of an unwholesome craving for roast beef—sought to assert his mastery over the earth. The dire consequences are plain to view. The earth is barren, domestic animals are ill-bred monstrosities beset by disease and riddled with parasites. Man himself has shrunken to be a neurotic, sunken-chested, weakly runt, whose unbridled carnal lusts have led him to overpopulate the globe without the slightest regard to his rapidly dwindling food supplies.

We would not agree with quite all of this, though our immediate surroundings sometimes tempt us to think that it is not without some content of truth. Alas, golden ages are an illusion. The so-called Golden Age of British Farming did not last a decade, the good old days were not particularly good, and, though anything seen in retrospect may appear a little rosier, our schooldays were not necessarily the happiest of our lives. We would rather regard living things in the wild state as being exposed to the most rigorous forces of natural selection, beset by predators and parasites and struggling desperately for the means of subsistence; in much the same condition, in fact, as was man before the advent of the welfare state.

What is it, we would ask, that keeps wild species as they are? What keeps the elephant's trunk as long as it is, but prevents it from growing longer? What gives the mole his admirable coat and his immoderate appetite? What determines the size of the mouse's whiskers? What gives the wild boar such an ungainly conformation and such execrable manners? Is it not the inexorably rigid forces of the environment that maintain the form and character of every species? And yet within each species there is potentially a great range of variation. Inherent in the germ plasm of the wild boar is the possibility of a Minnesota No. 1. That he chose to remain through the centuries ungainly and ill-mannered was not due solely to the circumstance that he was bigoted and unenlightened. Was it, perhaps, that these distressing qualities had considerable survival value in the sinister, dangerous primeval forests, and he remained as he was because he could not do otherwise? Those of his kind who diverged more than one bristle's breath from the party line speedily perished and were seen no more. Was it not only when certain species of plants and animals were protected by the art of the husbandman from the forces of natural selection, were liberated from its limiting and restricting influence, that they could give full expression to their inherent range of variation? Thus, by the selective art of the breeder, that snivelling nondescript cur who begged a bone from the brother-in-law of Swanscombe man became the ancestor of the Dachshund—short-legged enough to penetrate with ease into a badger's sett—of the Great Dane, swift of foot and strong enough to hunt the ungainly and ill-mannered wild boar, or of the bulldog who, tactful but inflexible, evicts courting couples from public parks where nightfall has overtaken them.

That snivelling nondescript cur itself could do none of these things—truly a marvellous feat of selective radiation!

The call to return to nature, to the simple things of life may be relevant to the obese business man suffering from a surfeit of *pâté de foie*, but it should not be allowed to spill over into a wider context. If it is the function, the very essence of agriculture to liberate cultivated species from the limitations of their normal environment, and then by a process of selective breeding to endow these species with useful qualities, then we should not seek to reverse this process. True it is that as each successive factor limiting production is removed so another limiting factor is revealed and its relative importance becomes the greater. Now that the possible causes of death in the human are greatly reduced, the absolute incidence and relative importance of the few that are left is much increased, yet one could hardly justify the suggestion that the increased number of deaths from old age is alarming, or that it is a dangerous consequence of irresponsible medical tinkering with health.

It has been suggested that the incidence and severity of helminthiases in grazing animals, far from having been reduced by domestication has, in fact, been increased. We doubt this. It was only a year or two ago that an eminent helminthologist, who should perhaps have known better, returned from darkest Africa amazed and horrified at the gigantic burdens of trematodes that he had found in game animals, and calling down hellfire and copper sulphate (much after the fashion of a sectarian lay preacher) on the unidentified molluscs of the entire continent. If wild animals do not live at peace with their parasites, there is little evidence to suggest that the improvement of husbandry methods has made matters progressively worse. No longer are real flounders to be found leaping alive in the liver of every sheep as they were in the days of Cobbet. It was the introduction of land drainage that permitted sheep to be successfully kept all over the British Isles. The factor now limiting their distribution to generally fluky localities where grazings are either unenclosed or divided by walls or ditches, is the high cost of maintaining hedges and fences. Whether the prohibitive cost of all manner of drainage works will lead to the total extinction of sheep will presumably depend, among other things, upon the relative price of mutton and carbon tetrachloride.

Agriculture as such, we appear to have established, is not incompatible with animal health; indeed there is a deep-rooted belief among farmers that good husbandry is an essential prerequisite to healthy stock. Good husbandry is a term which would seem to signify a variety of ill-defined concepts. To some farmers, no doubt, it conveys all that their conscience dictates and considerations of expediency absolutely forbid. To others, discerning enough to reject a facile picture of geometrically straight furrows and straw pheasants on the top of corn stacks, it may suggest a whole system of practices so integrated that all possible requirements are met by it, and the fertility of the land, the quality and health of the stock, and the prosperity of the undertaking are every day and in every way getting better and better. Alas, even the Norfolk rotation was not applicable to all situations, nor could it survive when wages and rents changed places as the highest and lowest in the list of production costs. Thomas Tusser himself, rhyming couplets notwithstanding, is regarded as having but little to offer to the problems of this unstable age. Traditional knowledge, however, should not be despised. Is it not one of the main outlets of research effort, in animal husbandry at least, to demonstrate that what was worked out empirically through the centuries is in fact sound? When the result of such researches can be summarised by an old proverb the animal husbandrist's claim to fame may be regarded as established. It is not for this reason alone that one may regard as unfortunate the total lack of traditional knowledge in the matter of grazing management and its relation to helminthiasis.

Some years ago, while we were industriously seeking information on farms where husk outbreaks had occurred, we made at least one curious observation. Those farmers who would have claimed to be progressive asked, "Why has this thing happened to me?" Those who had no such pretensions and were distinguishable by a brass-headed collar-stud and no collar asked, "Where has my husbandry been at fault?" While we were as ill-equipped to answer one question as the other, it was encouraging to find that at least those farmers to whom the stigma of being, in the language of officialdom, progressive or, worse still, intelligent was not attached, took it as a matter of course that animal disease was the outcome of faulty management.

The progressive gentleman, and as often as not his veterinary adviser also, expected a simple explanation. Unhappily, complex problems do not lend themselves readily to simple analyses. The aetiology of the social disease which was once picturesquely termed "a fluxe of the purse" is not adequately explained in terms of the single cause "women." Not only can this factor operate in many ways, but there are often alternative or additional factors such as "cards," "horses," "alcohol" or even "a weakness for glass paperweights." Sociological research into this disease should not, therefore, be aimed at determining which of these causes represented the true aetiology, nor would a detailed study of the relative dangers of Rococo and Early Victorian paperweights be of value as anything more than a subject for a Ph.D. thesis. Similarly, the more puzzling aspects of husk outbreaks in the dairy herd are not adequately explained in terms of such simple formulae as "rotational grazing," "unprotected dungheaps," or even "flatfooted cowmen."

The intimate connection between husbandry and helminthiasis is recognised even by the helminthologist; yet this curious race of men does not yet appear prepared unreservedly to forswear the over-simplified simple formula. Do not be surprised at this, gentle reader; the helminthologist, like the elephant, the mole and the ungainly and ill-mannered wild boar, is what he is on account of the rigid restricting forces of his environment. Veterinary helminthology, a veritable Cinderella among the sciences, is largely confined to the laboratory. Is it surprising that the

helminthologist should pause occasionally in his daily task, which is invariably concerned with the most unappetising materials, sit on his highly polished stool and dream? So it comes about that those who do not advocate polyandry in the interest of the clover seed are toying with a scheme to destroy nine out of every ten male infants.

For the sake of his sense of proportion the helminthologist must occasionally get out of his evil-smelling overcrowded laboratory. Fresh air is beneficial to his health, and the contemplation of a scouring lamb or a coughing calf is slightly more edifying than is the contemplation of a dead worm in a bottle. Are signs of this movement already perceptible? Here one carries untold hundredweights of mud off a mountainside in the pouring rain; there another cross-examines puzzled farmers and draws surrealist diagrams. Alas, while they help to perpetuate the impression that helminthologists are eccentrics, such activities can, at best, suggest only why this thing may have happened to the luckless gentleman farmer. In the matter of " Where has my husbandry been at fault " they do not do much more than provide fuel for further interminable scholastic disputations of the kind that helminthologists hold most dear.

The epidemiology of helminthic diseases is, may we be pardoned for mentioning it again, extraordinarily complex. The parasite in the course of its life cycle inhabits two, and in some cases three, environments, distinct and different yet all part of a single whole. The helminthological epidemiologist may well regard with envy the common or moorland ecologist whose problems by comparison seem ridiculously simple; for that there are three environments means that the complexity is cubed, not merely trebled. In the face of all this complexity, in the midst of countless relevant and interrelated factors, the helminthologist stands undaunted. With singular clearsightedness he can distinguish the relative importance of all these factors, and can fathom their relationships. Only give him ten snails in a pan of mud, or a handful of dung and three blades of grass in a flower-pot, and leave the rest to him. His recommendations will be lucid, clear, concise, and based on the most cogent of arguments. " Animals should be exposed to worm infection as young as possible," says one, " so that they may speedily acquire an immunity." " Expose them to infection for the first time late in life," says another, " when they have got a sufficient degree of age resistance." " Heavy stocking increases the risk of parasitism," says the first. " Heavy stocking helps to prevent parasitism," replies the second, " by keeping the herbage too short for larval survival." " Calves in the course of rotational grazing should follow behind older cattle who will have eaten off the infected herbage." " Calves should not follow older cattle since these are a source of infection." So these charming and diverting discussions go on. Do not laugh, dear reader. Spare a tear, nay, two if you have them. These are the utterances of the most intelligent of men, of the cream of scientific brainpower, gifted and eager, but held back by cruel circumstance in a bygone age where the truth was arrived at by reasoning alone. Between the contemplation of dead worms in bottles and the curious outdoor activities to which we have already alluded there lies a vacuum, a large desolate empty vacuum which superstitution, speculation, oratory, logic, deduction, reasoning, cogitation, meditation or calculation cannot satisfactorily fill.

One day, we suspect, this yawning chasm will be closed. One day, puffing and blowing, helminthology will arrive in the twentieth century. Imagine the frightening Wellsian, Orwellian, Huxleyan prospect, dear patient reader. Shrewd speculation from the armchair will give place to controlled experimentation, inspired deduction to proven fact. Truly, all the art, all the poetry, all the savour will have gone out of life and the subject abandoned to unimaginative, uninspired, half-human technologists. Not content, even, with more sophisticated laboratory experiments, and the beautiful thoughts that assail one while sitting on a hummock under a blue sky, they must needs question the most sacred tenets of parasitological dogma and seek to assess the effect and relative importance of different factors by actually varying them experimentally in preposterous situations where real live animals eat real grass on real pastures.

The day will come when these dark deeds will not only be thought possible but will be regarded as commonplace. Based on these firm foundations husbandry will progress, and our livestock, further disembarrassed of environmental restrictions, will become unwholesomely, unnaturally more productive.

May that day be soon.

Current Literature

BOOK REVIEWS

The Physiology of Domestic Animals. By H. H. DUKES, D.V.M., M.S. 7th edition. Published by Baillière, Tindall & Cox, price 75s.

The publication of the seventh edition of this textbook of veterinary physiology will be welcomed by all members of the veterinary profession as an indication of the desire of Professor Dukes to keep the book up to date. This edition includes contributions by Professors E. A. Hewitt, S. A. Asdell, K. A. Sumner, M. R. Kare and J. A. Dye, and it is obvious that the book has been extensively revised.

The book has increased in size by about 200 pages and most sections contain additional material. There are three completely new sections, one of which constitutes a brief account of the lecture-demonstration method of teaching physiology and appears rather unnecessary in a book of this nature. The policy of illustrating physiological principles with results obtained from experimental work on farm animals has been continued and extended. Comparative data are included wherever possible. Among the many subjects which have undergone revision are neuromuscular physiology, renal clearances, temperature regulation in cattle and the physiology of the equine and ruminant stomachs.

In general, it may be said that the book constitutes a balanced and readable account of the whole subject,

and the extensive bibliography which appears at the end of each section will serve as a very valuable introduction to the literature on any particular field. Any student who becomes thoroughly familiar with the contents of this book will have a sound understanding of the fundamentals of animal physiology.

Diseases of the Pig and its Husbandry by D. J. ANTHONY. Published by Baillière, Tindall & Cox, Price 25s.

Anthony's "Diseases of the Pig" has now reached its fourth edition, and if the author would depart from his tantalising circumlocution the book would be useful and readable. The author unfortunately never takes a short way of saying anything and the information he imparts therefore loses much of its directness. In those sections where he is dealing with matters about which there can be no great difference of opinion, for example the description of the various breeds, and in scheduled diseases, dentition, health and restraint, housing and management, he has much to say of use to the reader.

It is, however, when he deals with the scientific aspects of pig husbandry that the author is apt to be rather "old fashioned" and unwilling to accept anything new. He is obviously not quite familiar with some of the subjects he reviews, feeding for instance, and is apt to be side-tracked on to inconsequential comments which mean little. For example, he says: "Peanuts if fed without a supplement of calcium carbonate and cod liver oil result in poor growth, inappetence and unthriftiness." It would be difficult to imagine anything less likely than that someone would consider feeding a diet of peanuts. Unfortunately his attention to matters such as these, and his approach to them detract from the value of those sections of the book, which should prove of greatest interest to the man in practice who cannot hope to keep up with the frequent advances in husbandry recorded in the numerous journals and who hopes to get useful information from a reference book such as this should be.

It is unfortunate that some of the illustrations are poor and without purpose. Altogether it is difficult to recommend this new edition as the last word on "Diseases of the Pig" for veterinary surgeons. It falls between two stools, not really scientifically specific enough for the qualified man and too much play on words for the unqualified.

Antarctic Hazard. By W. ROSS COCKRILL. Published by Fredk. Muller. Price 15s.

In 1948 Mr. Ross Cockrill left behind him the tedium of interminable T.B. testing and joined an Antarctic Whaling Expedition as Whale Fishery Inspector and Veterinary Officer. Readers of THE VETERINARY RECORD will remember his absorbing paper on "Antarctic Pelagic Whaling" (*Vet. Rec.* 1951. **63.** 111-125).

Now he has written a book. It is an interesting and enjoyable book with which to spend an evening by the fireside, and it contains a great deal of particular appeal to the veterinary reader.

It should be said at once that if the reader wants a detached scientific account of Antarctic whaling, and of the veterinary problems associated with it, he will find this excellently done in Mr. Cockrill's 1951 article (referred to above). *Antarctic Hazard,* on the other hand, will give him a vivid and, at times, racy account of an Antarctic whaling expedition, with all its excitement, adventure and humour; and there is, too, a great deal of interesting information about the whaling industry in general.

The veterinary reader will find particularly interesting the discussion of problems of meat inspection and meat production under the hard working conditions of the Antarctic, and against a background of mistrust and resistance on the part of the "gunners," the aristocrats and petty dictators of the industry.

The book contains a good deal of entertaining descriptive writing, but there is a certain amount of repetition which tends to make the later passages of the book rather duller by comparison with the earlier sections. Mr. Cockrill should beware, too, of using the corny jest which he puts in the mouth of an angry Norwegian: "You t'ink I know dam' nothing, but I tell you I know dam' all!" "It was his peroration, and it satisfied him." So says Mr. Cockrill. Alas, it does not satisfy the reviewer, who heard the same remark attributed to a Goan clerk in East Africa in 1938. Jokes seem to travel as well as whalers!

However, these are minor blemishes, and the book can be thoroughly recommended for an evening's entertaining and interesting reading. It is, incidentally, plentifully illustrated, with some excellent photographs which have been well reproduced. Their inclusion must have set a problem for the binders; a problem which has not been too well solved.

Mr. Ross Cockrill, who is now on the staff of F.A.O. in Rome, is to be congratulated on an excellent and entertaining book, and we wish it all success.

Report of the Proceedings of the Society for the Study of Animal Breeding, 1951-3. 48 pages. Price 7s. 6d.

This publication is a collection of papers presented to the Society during the period 1951-3.

Although these papers have at various times during the past four years appeared in the columns of THE VETERINARY RECORD, the Society is to be congratulated on having gathered together the latest knowledge on this vast subject into one booklet.

The papers and symposia, all by eminent workers in their respective fields, may roughly be divided under the following headings:—

(a) the handling, storage and transport of bull semen.

(b) data regarding artificial insemination, conception rates, and herd improvement.

(c) fertility and infertility of cattle, including genetic aspects.

(d) the storage of bull semen at low temperatures.

This publication is most earnestly recommended to all veterinarians and others interested in the study of animal breeding.

News and Comment

THIS WEEK'S "RECORD"

It may be recalled that, in the later part of 1955, Council approved additional expenditure on the editorial content of THE RECORD in view of the increasing amount of work being offered for publication. The Editorial Committee decided, accordingly, that at fairly regular intervals the size of the journal should be enlarged in order to prevent a heavy backlog of papers or, alternatively, to accommodate work of importance that might be of substantial length. Such work has, in the past, tended to occupy an over-large proportion of our total space the week it appeared.

On this occasion, when the number of pages is increased to 48, an attempt has been made to offer a diversity of content, while at the same time publishing a weighty contribution on the artificial insemination of pigs that will be of interest to most veterinarians.

FOWL PEST

The fowl pest situation in Norfolk, Lancashire and Essex where "standstill" restrictions are in operation has been reviewed. The position in parts of Lancashire and Norfolk has considerably improved and Ministers have decided that the areas affected by these restrictions can now be reduced.

In Essex a number of outbreaks of disease have occurred recently at widely separated premises outside the present Infected Areas in north and south Essex; Ministers have accordingly decided to extend the scheduled area.

As from January 19th, the "standstill" restrictions will apply only in the areas specified below:—

NORFOLK

The City and County Borough of Norwich and the County Borough of Great Yarmouth.

In the County of Norfolk—The Petty Sessional Divisions of Blofield and Walsham, Depwade, East and West Flegg, Eynsford, Forehoe, Gallow, Holt, Loddon and Clavering, Mitford and Launditch, North Erpingham, North Greenhoe, South Erpingham, Taverham, and Tunstead and Happing.

EAST SUFFOLK

In the County of East Suffolk—Petty Sessional Division of Mutford and Lothingland, the parishes of Burgh Castle and Bradwell.

LANCASHIRE

The County Borough of Preston.

In the County of Lancaster—The Borough of Chorley and the Petty Sessional Divisions of Leyland, Leyland Hundred and Walton le Dale.

Petty Sessional Division of Amounderness, the parishes of Fulwood and Lea.

Petty Sessional Division of Fylde, the parishes of Newton with Clifton, Freckleton and Bryning with Warton.

Petty Sessional Division of Wigan, the parishes of Parbold, Wrightington, Shevington, Standish with Langtree and Worthington.

ESSEX

The Administrative County of Essex and the County Boroughs of East Ham, Southend-on-Sea and West Ham.

THE 1956 CONGRESS

We publish below a list of hotels in and near Leamington Spa. In the case of those outside, the approximate road mileage is given. We are asked to emphasise *most strongly* the necessity for early reservation of accommodation. Members should make their arrangements direct with hotels mentioning that they are attending Congress.

On the Thursday evening of Congress week (September 20th) it is hoped to arrange a visit to the current performance at the Shakespeare Memorial Theatre at Stratford-on-Avon. It is not yet known what play will be performed, but this information will be published later. The cost of tickets will be about 16s. each, and because block bookings have to be made in very good time those who would like to reserve places are asked to write at their earliest convenience to the General Secretary of the B.V.A. at 7, Mansfield Street, London, W.1. It is important that enquiries should *not* be made to the theatre at this stage.

HOTELS IN LEAMINGTON SPA

	Charge for Bed and Breakfast £ s. d.
Regent Hotel	1 1 0
Crown Hotel	19 6
Manor House Hotel	1 5 0
Spa Hotel	1 1 0
Marlborough Hotel	19 6
Oaks Hotel	1 1 0
New Clarendon Hotel	1 5 0
Chesford Grange (3 miles)	1 5 6
Private Hotels—	
Angel, 145, Regent Street, Leamington Spa	16 9
Alkerton, Binswood Avenue	17 6
Amersham, Kenilworth Road	17 6
Arden, Clarendon Square	18 6
Armathwaite, Kenilworth Road	1 1 0
Bankfield, Newbold Terrace	17 6
The Lachine, Newbold Terrace	16 6
Roselands, Binswood Avenue	17 6
Sheiling, Beauchamp Avenue	1 1 0
Westella, Leam Terrace	15 0

HOTELS OUTSIDE LEAMINGTON SPA

Lord Leicester, Warwick (2 miles) ...	1 1 0
Woolpack, Warwick (2 miles)	17 6

Queen & Castle, Kenilworth (5 miles) ...		16	6
Abbey, Kenilworth (5 miles)	1	1	0
Rouncil Towers, Motel, Kenilworth (5 miles)	1	8	6
Leofric Hotel, Coventry (9 miles)	1	17	6
Glebe Hotel, Barford (Private) (4 miles)	1	1	0
Kings Head, Wellesbourne (6 miles) ...		17	6
Falcon Hotel, Stratford-on-Avon (10 miles)	1	5	0
Red House Hotel, Stratford-on-Avon (10 miles)	1	5	0
Ettington Park, Ettington, Warwick (12 miles)	1	1	0
Craven Arms, Southam (7 miles)		16	0
Welcombe Hotel, Stratford-on-Avon (10 miles)	2	5	0

UNIVERSITY NEWS

Liverpool

Second B.V.Sc. Examination, January, 1956. Part I, Veterinary Anatomy (including Histology and Embryology) and Part II, Physiology (including Biochemistry).

Alderson, Valerie A.; Batt, R. A. L.; Beadle, G. G. (with distinction in Biochemistry); Bryan, N. M.; Davidson, P. A. S.; Davies, A.; Ducker, M. C.; Edwards, J.; Haywood, R. H.; Hothersall, Maureen; Ingman, N. R.; Janes, P. D.; Lloyd, Anne S.; Lloyd, R.; MacArthur, G. J.; McFarland, A. G.; Pearson, P. D.; Penhale, W. J.; Perry, K. T. E.; Proctor, G. M.; Robson, J.; Sulley, M. J.; and Vivian, J. S.

Passed in Part I only.
Davies, H. S.

Glasgow

The 1955/6 academic session began in Glasgow early in October with the customary students' reunions. Later in that month came the first event of note, a reception and concert given in the old college at Buccleuch Street for the benefit of the new students. All first year students and members of the teaching staff were invited by the G.U.V.M.A. Council to an excellent tea provided by the women students' union, and afterwards there was a concert, open to all, given by students and by Mr. Sydney Jennings. It was hoped that this occasion would introduce first year students to the rest of the veterinary school since the first year subjects are taught in the main university departments, geographically apart from the rest of the veterinary course.

The traditional Field Day with the Royal (Dick) Veterinary School was held in mid-November at Glasgow. A strong Glasgow men's hockey team lost (3—1) to the Edinburgh team, although, in the "battle of the Amazons," the Glasgow women students' hockey team beat their Edinburgh counterparts (3—2). Glasgow also, for the first time in many years, won the football game, and handsomely (4—1), and won the rugby game (6—3) after losing their captain, with a fractured rib, in the first few minutes of the game. This latter was a very exhausting struggle since the referee's watch stopped in the first half, which went on for 50 minutes in consequence! That evening an enjoyable informal dance was held at Buccleuch Street as a suitable finale to the evening's traditional revelry.

Four meetings of the Clinical and Debates Club were held during the term. The first took the form of short papers presented by four final year students on interesting cases they had seen during the summer vacation. The second was a paper given by Mr. Brian Martin of final year on "Lameness in the Racing Greyhound" which dealt very capably with this aspect of a rather specialised branch of veterinary work. At the third meeting, Mr. Craig Sharp of final year presented a paper on "Bracken Poisoning in the Bovine"—an interesting account of a condition quite commonly encountered—in which pathogenesis and treatment were discussed in detail in the light of the most recent researches. A lively discussion followed both papers. Finally, an American film, on hog cholera, kindly loaned by the Liverpool veterinary students' society, was shown one lunch-time to members of the final year.

Academically, the work last term proceeded apace. The new buildings, at Garscube, at last are approaching completion and both students and staff are coming to appreciate increasingly the excellent facilities they provide for veterinary instruction.

The present term began late enough for most people to have recovered from the New Year celebrations. Half of the re-sit finals examinees of December, however, remained to remind final year students of the tasks ahead in June. This term is marked by two big social events in February, the G.U.V.M.A. Annual Ball, in the Rhul, Sauchiehall Street, on February 10th, and the annual conference of the A.V.S., which is to take place here in Glasgow on February 18th, 19th, and 20th. Meetings were held throughout last term to make the many necessary arrangements for this latter event and a successful conference is anticipated.

PARIS ART EXHIBITION

The 28th Salon of works by veterinarians, doctors, dentists, and pharmacists will be held from March 4th to 25th, at the Museum of Modern Art, Avenue du President Wilson, Paris. It will comprise sections of painting, sculpture, decorative art, photography and applied art.

Entries should be made by February 15th, and further particulars may be obtained from the Secretariat, 67, Avenue Pierre Larousse, Malakoff, Seine. Intending exhibitors are asked to send details of name, address, qualifications and titles of exhibits to that address. They should send the exhibits themselves, bearing the same information, to Messrs. Davies Turner Ltd., 47, Graham Terrace, S.W.1., and *not* directly to Paris.

HOLIDAY EXCHANGE

A 26-year-old Swiss veterinary student in his seventh semester at Zürich University would like to stay in England some time between the end of February and the beginning of April.

He hopes to see an animal hospital or a small-animal practice in London, and speaks fairly good English.

The 21-year-old daughter of a French veterinary surgeon would very much like to spend the Easter holidays *au pair* or as a paying guest with a veterinary family in the London area or near to it.

Would any member interested in any of these suggestions kindly get in touch with the General Secretary, B.V.A., 7, Mansfield Street, Portland Place, London, W.1.

THE LABORATORY ANIMALS BUREAU

The ninth Laboratory Animals Bureau Congress will be held at The Royal Veterinary College, London, on Wednesday and Thursday, April 11th and 12th. A provisional programme is now available. Admission to the Congress is normally restricted to animal and laboratory technicians and is by invitation.

Applications for invitations should be sent immediately to the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3, either by individuals or by heads of departments on behalf of their technicians.

The Fourth Laboratory Animals Bureau Symposium will be held at The Royal Veterinary College, London, on Friday, April 13th. The subject of the Symposium will be "Infections of Laboratory Animals." Professor J. W. Howie, Department of Bacteriology, University of Glasgow, will be in the Chair. Admission to the Symposium is open to scientific, medical and veterinary graduates for whom it is primarily intended. Senior technicians will also be welcome. No application for invitation is necessary, but those requiring lunch and tea are particularly requested to reserve places with the Bureau.

Supplies of Animals

The present position of the supply of animals is as follows:—

Guinea-pigs: Serious shortage now and for the next few months.

Mice: Some shortage now and for the next few months.

Rabbits: No change.

Rats: Obtainable in limited numbers. Slight increase in price.

Hamsters: No change.

Other rodents: No change.

Cats: The Bureau is unable to recommend any thoroughly reliable cat dealers. If and when a reliable source becomes available, laboratories will be informed through Parade State.

Ferrets: No change.

Monkeys: Enquiries for monkeys should be addressed to the Bureau. As a result of the Director's recent visit to India, the supply of Rhesus monkeys should now be assured but the method of obtaining them has undergone some new developments.

Frogs and Toads: No British frogs and toads will be available until the end of the hibernation period, *i.e.*, late February or early March. Imported European species are in short supply; recent consignments have proved unreliable.

Other species: No change.

PERSONAL

Births

CLARKSON.—On January 3rd, 1956, at 163, Beresford Road, Birkenhead, to Margaret and Michael, the gift of a daughter, Ruth Ann, a sister for Daniel.

HAWKSLEY.—On December 23rd, 1955, at 29c, Sunningfields Road, Hendon, N.W.4, to Betty (*née* Nicholson), wife of Michael Hawksley, B.SC., M.R.C.V.S.,—a son, Christopher Michael Gerald, a brother for Jane.

JAMES.—On January 20th, 1956, to Joan, wife of Terence Morton James, M.R.C.V.S., of Rock Cottage, Newtown, Monts, a son, Nigel Morton.

ROBERTS.—On January 16th, 1956, at Widmore Road Maternity Home, Bromley, Kent, to Dorothy (*née* Cradduck), wife of H. G. Roberts, M.R.C.V.S., a son. Ian Nigel, brother for Sandra.

THRELKELD.—On December 3rd, 1955, to Lilian, wife of James M. Threlkeld, of 2, Lilac Grove, Redcar, Yorks, a daughter, Julia Frances, sister for Valerie and Jane.

R.C.V.S. OBITUARY

We record with regret the death of the following members of the profession:—

BRAIN, Thomas James, 80, St. George's Road, Cheltenham, Glos. Graduated London, May 12th, 1893. Died January 18th, 1956, aged 84 years.

LEESE, Arnold Spencer, 20 Pewley Hill, Guildford, Surrey. Graduated London, July 15th, 1903. Died January 18th, 1956.

MR. T. J. BRAIN

Mr. H. W. Dawes writes:—

By the death of Mr. T. J. Brain of Cheltenham, at the advanced age of 84, the Midlands has lost one of its outstanding veterinary personalities.

"T.J.," as he was affectionately known to many of us, had practised in that town for over 60 years. He was a well-known and outstanding figure, a fine horseman and a first-class judge of a horse, whether made or in the rough. He was seen at his best in equine practice and for many years his opinion was highly valued in many parts of the country. He had hunted with Cotswold and V.W.H. since boyhood, and was riding regularly to hounds until he was nearly 70 years of age. A bad fall a few years ago led to his gradual retirement from practice, in which his son succeeded him.

Keenly interested in racing, he had been veterinary surgeon to Cheltenham Race Committee since its inception and he was a familiar figure at the National Hunt Festival. At one time, he had several of his own horses in training.

He took a great interest in matters appertaining to

his profession and was, for many years, a member of the Midland Counties Division and had occupied the Presidential chair. When, some years ago, his son, in due course, became President of the "Midland," it was a source of great pleasure to his father.

"T.J." was a kindly host, with a fund of anecdote and a lively sense of humour; and the writer well recalls his spare, erect figure, then in his eighties, surrounded by his friends at Cheltenham Horse Show. His many friends were filled with admiration by his fortitude during the last period of his life, and death came to him as a friendly summons.

By his passing, an outstanding individual in the veterinary profession has gone, and we, his colleagues, are the poorer for his loss.

Ave atque vale.

COMING EVENTS

January

30th (Mon.). Meeting of the Section of Comparative Medicine of the Royal Society of Medicine at the Society's house, 5 p.m.

February

1st (Wed.). General Meeting of the Sussex Veterinary Society at Old Ship Hotel, Brighton, at 2.30 p.m.

Meeting of the Southern Counties Division, B.V.A., at the Polygon Hotel, Southampton, 7.30 p.m.

3rd (Fri.). Meeting of the Technical Development Committee, B.V.A., at 7, Mansfield Street, Portland Place, London, W.1, 10.30 a.m., to receive further articles on calf diseases.

Annual General Meeting of the Northern Ireland Division, B.V.A., at Queen's University, Belfast, 7.30 p.m.

8th (Wed.). Meeting of the R.A.V.C. Division, B.V.A., at University of Cambridge, at 12 noon.

10th (Fri.). Annual Ball of the Glasgow University Veterinary Medical Association in the Rhul Restaurant, Sauchihall Street.

Annual General Meeting of the Yorkshire Division, B.V.A., in Leeds, 2.30 p.m.

14th (Tues.). Annual General Meeting of the Eastern Counties Division, B.V.A., at the Bell Hotel, Norwich, 11 a.m.

16th (Thurs.). Annual General Meeting of the South-Eastern Division, B.V.A., at the Royal Star Hotel, Maidstone, 2.30 p.m.

17th (Fri.). Annual Ball of the Royal (Dick) School of Veterinary Studies in the Assembly Rooms, George Street, Edinburgh, 8.30 p.m.

22nd (Wed.). Second Meeting of the A.V.T. and R.W's. Scottish Regional Group for the 1955-56 session in the Moredun Institute, Edinburgh, 2.15 p.m.

ADDRESSES OF DISEASE INFECTED PREMISES

The list given below indicates, first the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax

Cumberland. Grassgarth, Welton, Carlisle (Jan. 23).

Derby. Yew Tree Farm, Hardstoft, Pilsley, Chesterfield (Jan. 18); Ashmore Farm, 27, High Street, Tibshelf (Jan. 19); Manor Farm Butchery, Breedon-on-the-Hill (Jan. 21); Hill Top Farm, South Normanton (Jan. 23).

Durham. Middle Belasis Farm, Haverton Hill, Billingham (Jan. 20).

Kent. Upper Austin Lodge Farm, Eynsford, Dartford (Jan. 21).

Lancs. Springfield Farm, Babylon Lane, Heath Charnock, Chorley (Jan. 17).

Leics. Home Farm, Hickling, Melton Mowbray (Jan. 20); Springfield Farm, Tilton-on-the-Hill, Leicester (Jan. 23).

Northants. Hillstone Farm, Stanwick, Wellingborough (Jan. 18).

Northumberland. Hollin Close Farm, Allendale, Hexham (Jan. 23).

Salop. The Holding, Rednal, West Felton, Oswestry (Jan. 21).

Yorks. Moor Farm, Kelfield; Bramble Hill Farm, Woodmansey (Jan. 17); Patterie Carr Farm, Loversall, Doncaster. Middle South Farm, Warsill, Pateley Bridge, Harrogate (Jan. 18); Star Carr Farm, Haxey, Doncaster; Lowfield Farm, Ganstead, Hull; Bank House Farm, Eccup, Leeds, 16; Lower Swainroyd Farm, Sandy Lane, Allerton, Bradford; White House Farm, Holdworth, Bradfield, Sheffield; Whinmoor, West Heslerton, Malton (Jan. 19); Old Hall, Burstwick, Hull (Jan. 20); Southfield Farm, Preston, Hull; Bottom Farm, Kettlesing, Harrogate (Jan. 21); Meaux Road, Wawne, Hull; Heaming Farm, Thoralby, Leyburn (Jan. 23).

Fowl Pest

Carmarthen. Crolsfan, Uchaf, Llandilo (Jan. 20).

Ches. Wood End Farm, Mobberley, Knutsford (Jan. 17).

Essex. Bon Homme, Third Avenue, Lower Dunton Road, Laindon, Basildon (Jan. 19).

Hereford. 19, Prospect Cottages, Hereford Road, Leominster (Jan. 17).

Lancs. Moorthorpe Drumacre Lane, Longton, Preston (Jan. 18); Brookfield Farm, Old Lane, Off Chapel Lane, New Longton, Preston (Jan. 21); Odd House Farm, Little Hoole, Preston (Jan. 23).

Norfolk. Lyng Hall Farm, Wood Norton, Dereham (Jan. 17); Allotments, Dereham Road, Scanning; 5, New Row, Fulmodeston, Dereham (Jan. 19); Brookhill Farm, Thursford, Fakenham (Jan. 20).

Oxford. Weir Farm, Blackthorn, Bicester (Jan. 19).

Swine Fever

Beds. Rose Farm Dairy, Wingfield, Dunstable (Jan. 20).

Berks. Manor Farm, Coombe, Newbury (Jan. 23).

Dorset. 60, Lonnen Road, Colehill, Wimborne (Jan. 19).

Glos. 3, Elmore, Gloucester (Jan. 20).

Norfolk. Clay Hall Farm, Great Witchingham, Norwich (Jan. 19).

Somerset. Venn Farm, Brushford, Dulverton (Jan. 23).

Sussex. Bow Hill Piggeries, East Marden, Chichester (Jan. 19).

Worcs. Home Farm, Ribbesford, Bewdley (Jan. 23).

Yorks. Summer Croft Farm, Haxey, Doncaster (Jan. 19); Eastfield Farm, Bishop Burton, Beverley (Jan. 23).

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

Endotracheal Intubation in Cattle

Sir,—The article on Endotracheal Intubation by A. Messervy and E. Wynn Jones published in your issue of January 14th, 1956, draws attention to what is undoubtedly the safest method of anaesthesia in ruminants.

One point in the paper which I should like to take up is that it is not necessary to use instruments to

introduce the Magill tube into the trachea of small ruminants.

If the animal is placed on its back with the head hanging over the edge of the table, then by withdrawing the tongue and holding the Magill tube concavity uppermost, it can be very easily slipped into the trachea.

The safety of this method of anaesthesia can be judged by the fact that during the last two years we have operated on more than 400 sheep without losing a single animal, whereas prior to adopting this technique 10 per cent. of sheep operated on became casualties due to inhalation of regurgitated rumen contents.

Yours faithfully,

L. E. ROWSON.

Cambridge and District Cattle Breeders Ltd.,
The Gravel Pits,
Huntingdon Road,
Cambridge.

January 14th, 1955.

Electrical Stunning and Humane Slaughtering of Animals

Sir,—Rabbi Sassoon in his letter published in THE VETERINARY RECORD of January 21st, admits that a report of an investigation, in which the electroencephalograph was employed, has not been made public.

Unless it is published how can one be expected to agree that the conclusions which Rabbi Sassoon draws are scientifically sound?

May I ask, through you, sir, that the Rabbi endeavours to persuade those who have the report to allow it to be published in a reputable scientific journal?

Yours faithfully,

H. E. BYWATER.

Essex House,
High Street,
Stratford, E.15.

January 23rd, 1956.

The Use of "Xylotox"

Sir,—I was interested to read the note by Colonel Rainey in the January 7th issue of THE RECORD, but would be extremely hesitant to accept the suggestion that "Xylotox" was responsible, even indirectly, for the death of the foal through haemorrhage. It would be interesting to know whether haemorrhage occurred from one or both spermatic cords.

Having used " Xylotox " as the standard local anaesthetic in a large practice for over two years, including its use in castration of equines, bovines and swine, we have never observed any indication of a tendency to cause haemorrhage, and the popularity of this preparation in dentistry would seem to preclude this. It will be appreciated that "Xylotox" veterinary, as sold in this country, contains 1 in 50,000 adrenaline hydrochloride, the solution commonly employed in dental practice contains about 1 in 80,000 of the same agent, which is, of course, a most powerful vasoconstrictor. At a recent " dehorning session " we ran out of " Xylotox " and the only local anaesthetic available to us for immediate use was a solution of procaine *without* adrenaline. Whilst this acted as a satisfactory anaesthetic, it was noticeable that haemorrhage was much more marked in the animals on which it was used.

A hurried search in the somewhat inadequate literature immediately available to me describes the toxic actions of cocaine, procaine and lignocaine as being those of excitement and, later, respiratory paralysis. The risk is very much greater should the injection be given intravenously. I can, however, find no reference to any of these drugs acting upon the smooth muscles of the blood vessels as suggested by Col. Rainey's letter. It would be interesting to hear the comments of a physiologist on this point. On the other hand, however, haemorrhage following castration in all species, regardless of the type of anaesthetic used, is occasionally noticed, due possibly to bad technique or even haemophilia of the patient. The fact that Col. Rainey has never observed such a case in nearly 60 years of experience, is somewhat of a tribute to his skill.

Yours faithfully,

L. GUY ANDERSON.

49, Cambridge Street,
Aylesbury,
Bucks.

January 10th, 1955.

Sir,—I can assure Colonel Rainey that "Xylotox" is satisfactory for the production of anaesthesia for the castration of colts. I have used it as a routine method for a long series of cases. It was most unfortunate that his first trial should result in a fatality.

My experience is that results are certain if the injection is made into the centre of the substance of each testicle with a needle of a fairly fine bore and not more than 3 cm. in length. Injection into the cord is not reliable as the contents of the syringe may be emptied into the spermatic artery or into a vein with little local effect. A large-bore needle passed into the testicle frequently causes a haematoma which is of little importance as the damaged vessel is excised during the operation; but if passed into the spermatic artery above the line of eventual section, as might occur in an animal with a partially retained testicle, the large-bore needle could cause a dangerous haemorrhage.

I hope that Colonel Rainey will give the method further trial and find that "Xylotox" is in no way dangerous and that his Tasmanian colleagues were giving him useful advice.

Yours faithfully,

A. C. FRASER.

The Green,
Aldbourne,
Marlborough,
Wilts.

January 7th, 1956.

Distemper

Sir,—I should like to thank Mr. Singleton and Captain Hunter for an interesting and really clinical paper which should provide plenty of scope for discussion, by correspondence, and enlightenment therefrom. Of course, in private practice, one seldom

has the advantage of being able to have an epidemic virus typed, or the time for full case recording; but one does see symptoms repeated sufficiently often for impressions to be formed.

For instance, if owners of patients are questioned, an inordinate number of them will recall one vomition some 10 days prior to the onset of general illness and anorexia. I believe this coincides with the initial, and decidedly short lasting, pyrexia as demonstrated by Laidlaw & Dunkin. It appears to me that this has been missed in the Melton Mowbray outbreak, and one wonders how many of the dogs were inoculated too soon after arrival, or while incubating the disease.

I have had occasion recently to destroy two pedigree dogs with chorea following inoculation with egg-adapted distemper vaccine. One may argue that inoculation was imposed upon a dog in the period between the end of apparent illness and the onset of nervous sequelae. This period may be as long as six weeks, and nervous symptoms have been known to develop after the shortest and mildest of syndromes, namely one day of pyrexia and diarrhoea. Alternatively, the vaccine provided may not have been sufficiently attenuated and still slightly pathogenic.

The literature supplied with the vaccine recommends the therapeutic use of the product, as did that with the vaccine of the original vaccine-virus method, but in this practice this has only met with failure.

One must remember that the virus of the distemper complex can invade any tissue of the body, and being neurotropic can, and does, penetrate the central nervous system early, as instanced by the occurrence of one single fit at the time of the initial temperature rise. The molecule embodying the antibody, as administered in serum, is incapable of penetrating the meningeal barrier, so even if injected very early in the disease not all the infection may be neutralised.

Yours faithfully,

R. N. PHILLIPS.

139, London Road,
Ipswich.

January 15th, 1956.

Diagnosis of Reticulitis

Sir,—Mr. Eric Williams's recent paper on the diagnosis of traumatic reticulitis prompts me to suggest further trials of a test which appears to be far from widely known. It is cheap, easy and, I believe, remarkably accurate.

I refer to the Sulkowitch Test. The reagent is a stable, buffered oxalate solution, 5 c.c. of which is add to 5 c.c. of the cow's urine. A turbidity results if there is calcium present in the urine, as there is normally. In those cows suffering from a *penetrating* foreign body there is no calcium in the urine and consequently no turbidity occurs when the reagent is added. The explanation of this absence of calcium I leave to the pathologists.

Unfortunately, in three and a half years I have been able to apply this test to only six cases of suspected reticulitis. In all cases the test was positive for a penetrating body and was confirmed at operation or *post-mortem* examination. There have been two or three vague cases of possible reticulitis but each gave a negative test for foreign body. Only one of these was confirmed as a true negative at *post mortem* but, to my knowledge, the others did not develop reticulitis subsequently.

In addition I have sampled over 50 urine specimens from normal cows. All have given a positive reaction for calcium with the single exception of a cow that had calved approximately only 12 hours prior to the test.

The most recent case of reticulitis is particularly interesting as I believe it demonstrates the sensitivity of the test. Briefly the details are:—

June 29th, 1955	Friesian cow. Vague symptoms of dyspepsia. Sulkowitch Test negative for penetrating body.
June 30th	Tentative diagnosis of reticulitis —confirmed by positive urine test for penetrating body.
July 1st	Prepared to operate but apparent, spontaneous recovery following starvation. Sulkowitch Test now negative again.
January 6th, 1956	Symptoms similar to those of June 29th. Sulkowitch Test positive for penetrating body.
January 7th	Some improvement. Owner loth to permit operation. Sulkowitch Test still positive.
January 8th	No change. Sulkowitch Test still positive on two separate urine samples. Rumenotomy. Removed penetrating 2-inch wire.

Only with wider use will the test find its true level. If it is as accurate as I believe, it should prove extremely useful in large-animal practice with its obvious, great advantages over the blood picture and mine detector tests. When combined with the reticular grunt method of Williams it may offer enhanced accuracy of diagnosis. By itself it recently gave a positive result in the absence of a reticular grunt when there was a temporary, but complete, ruminal stasis.

The use of the test for this purpose was first described by Silver (1951).

The formula of Sulkowitch reagent is as follows:—

Oxalic acid, 5.0 grammes; ammonium oxalate, 5.0 grammes; glacial acetic acid, 10.0 c.c.; distilled water, to 300.0 c.c.

Yours faithfully,

SHERWIN A. HALL.

12, South Street,
Dorchester,
Dorset.

January 9th, 1956.

Reference

SILVER, J. (1951). *N. Amer. Vet.* **32.** 829.

ADVERTISER'S ANNOUNCEMENT

EVANS MEDICAL SUPPLIES LTD., announce that Nobecutane Marking Ink in 50 ml. screw cap bottles is now available. This is a plastic ink consisting of an ethyl acetate solution of a cellaquer blue dye mixed with Nobecutane, and it is intended as a surgical marking ink which will withstand the rigorous pre-operative preparation of the skin and provide lasting delineation.